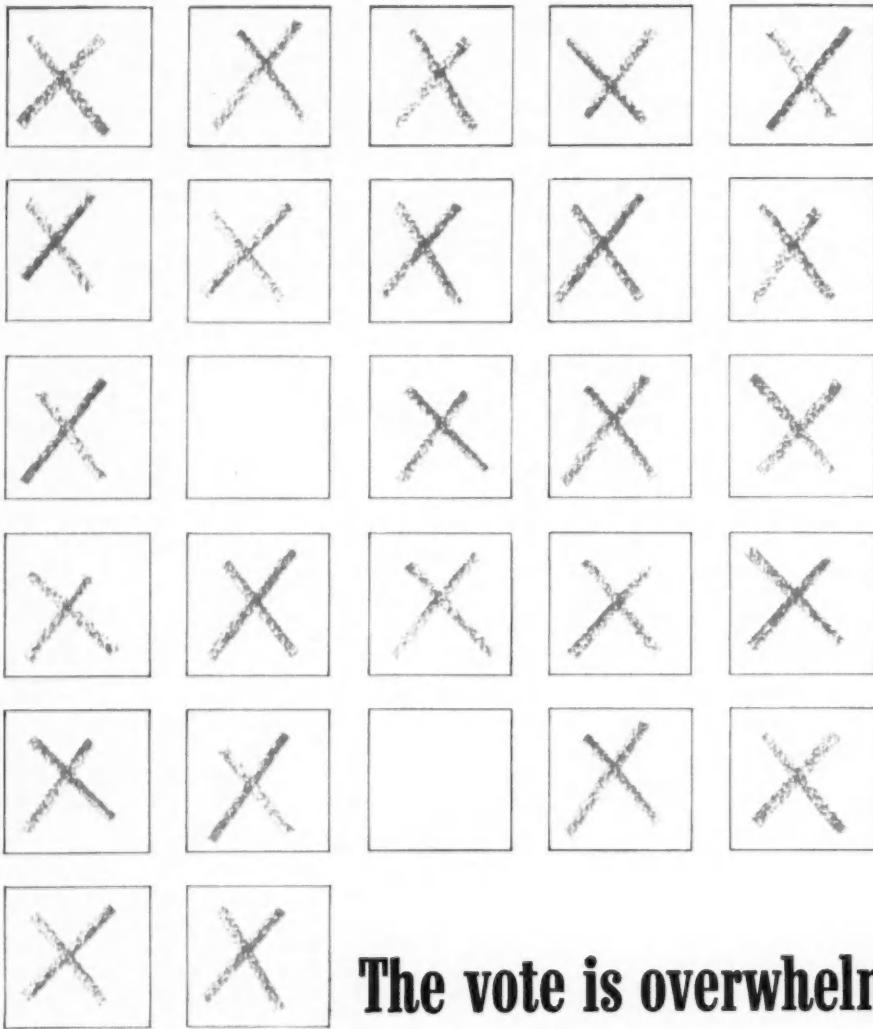


SAE *Journal*

JULY 1952

SUMMER MEETING ISSUE

PUBLISHED BY THE SOCIETY OF AUTOMOTIVE ENGINEERS



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Letter

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DD Details of Design (Part II)
EL Enclosure & Lubrication (Part III)
LC Bearing Load Computation (Part IV)
AP Application Procedure (Part V)
LF Full Scale Drawings of Bearings
H Tables, formulae, bearing principles,
load computation, bearing installation

MAINTENANCE AND SERVICE

SP Service Procedure for Ball Bearings
R Interchangeable Replacement Bearings
FW Front Wheel Adjustment Chart

GENERAL

S Standard Catalog (Handbook, Vol. I)
BI Explanation of numbering system
D Sealed bearings (Discussion of Principles)
IB Ball Bearings for the textile industry
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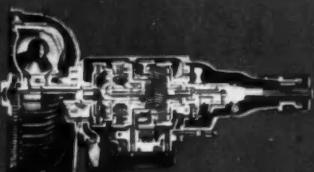


NEW DEPARTURE BALL BEARINGS

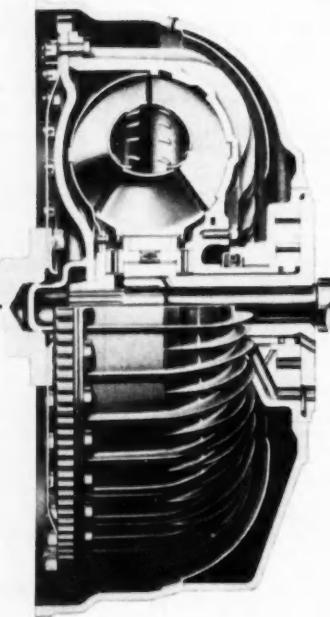
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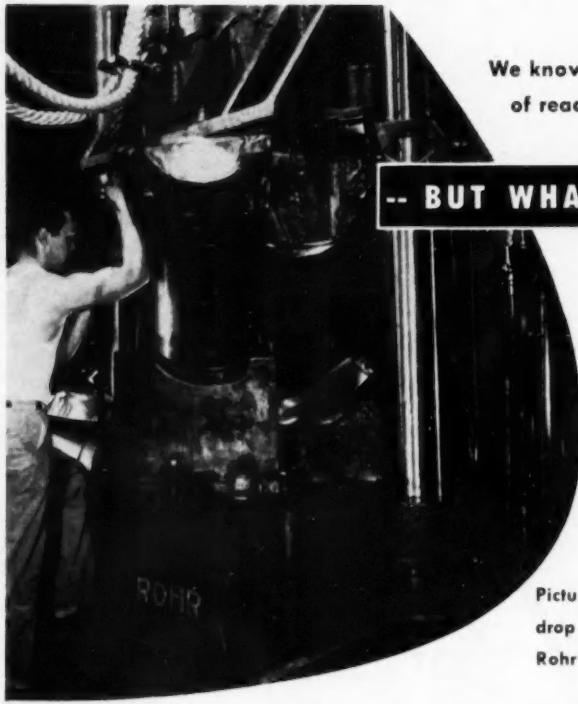
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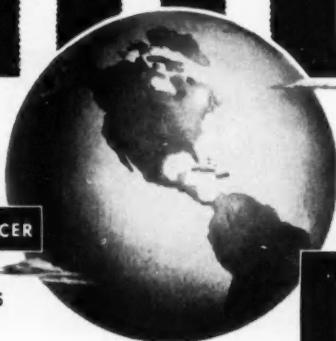
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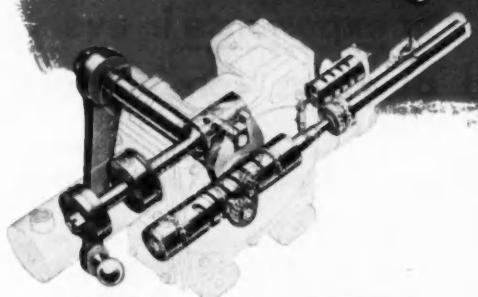
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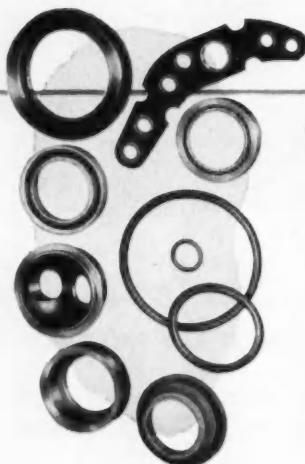
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Affiliated with Graton & Knight Company*

Study of materials and their components has been Mr. Eagan's life work, and he can be credited with many of the rapid advances in the use of synthetic rubbers. After graduating from Clark University with a B.S. and M.S. degree in Chemistry, he was an analytical chemist for 9 years. At Graton & Knight for 11 years, first as Chief Rubber Chemist, now as Technical Director of International Packings Corporation, it has always been his job to select the proper materials for a given packings application—and to supervise quality control in every stage of production. Member of the Rubber Division of The American Chemical Society and Society of Automotive Engineers.



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"Something new has been added" to the six billion dollar milk industry...

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or durability. Another all-important advantage is that they are easy to clean, and to keep clean.

Leading steel companies produce austenitic chromium-nickel stainless steels in all commercial forms. A list of sources of supply will be furnished on request.

At the present time, the bulk of the nickel produced is being diverted to defense. Through application to the appropriate authorities, austenitic stainless steels are obtainable for many end uses in defense and defense supporting industries. Counsel and data on alloys containing nickel, for your present production or future projects, are yours for the asking. We invite your inquiries.



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STANDARD

THROUGH THE YEARS



Pioneered and perfected by Aetna, the T-Type Bearing is the Nation's No. 1 bearing for the clutch release position. It is original equipment in

more than half of the "on-and-off-the-highway" mobile vehicles built today. Add this bearing's 18-year leadership to its matchless features — to Aetna's traditional practice of cooperative research and engineering — to Aetna's ultra-strict quality control methods and manufacturing skill and you have every significant reason why Aetna is the recognized source of the world's finest clutch release bearings. Aetna Ball and Roller Bearing Company, 4600 Schubert Avenue, Chicago 39, Illinois.

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1940
1949
1951
1952



Aetna

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1952
Mobilgas Economy Run
Proved Again

B-W Overdrive

pays off!

Top 10 cars (on miles-per-gallon basis) including Sweepstakes winner—
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25.8 MILES PER GALLON

Again this year the records proved: B-W Overdrive means more miles per gallon of gas!

In the grueling, 1415.4-mile Mobilgas Economy Run—sanctioned and supervised by the Contest Board of the AAA—the 10 best actual miles-per-gallon records were made by 1952-model cars equipped with Borg-Warner Overdrive.

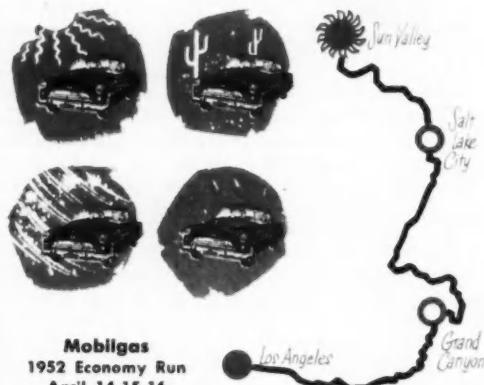
And in every year of this annual contest, the ton-miles-per-gallon Sweepstakes winner has been equipped with this famous Borg-Warner transmission unit.

What better proof could you want of real fuel economy?

3 MILES "FREE" IN EVERY 10!

An advanced-type transmission, B-W Overdrive automatically cuts engine revolutions 30%. At 50, for instance, the engine is taking it easy at only 35! That saves gas—hands the owner as much as 3 miles "free" in every 10. Saves engine wear, too—means longer life and fewer repair bills.

Made exclusively by B-W's Warner Gear Division, Overdrive is now offered on 11 leading makes of cars. Proof again that . . . B-W engineering makes it work—B-W production makes it available.



Mobilgas
1952 Economy Run
April 14-15-16

Sanctioned and Supervised by
Contest Board A.A.A.

Toughest car driving contest in all the world . . . spanning all four seasons and all-year driving conditions in a 35-hour run of 1415.4 miles from Los Angeles to Sun Valley, Idaho, over a course with altitude from 70 ft. below sea level to 8010 ft. above . . . from mountains to desert, and from icy roads to intense heat.

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For the Sake of Argument

Know Your "Helpers"

By Norman G. Shidle

The ways of approach to other people's problems are as varied as the people who do the approaching. For instance:

1. **The I'll-do-it-for-you type:** This good-hearted soul is always ready to drop his own work and take yours on. He likes to be liked, and he does anything for anybody. He leaves you saying: "What a wonderful guy he is. He's always helpful." But he hasn't helped you to face the same sort of problem next time. His helpfulness is limited to the immediate time, place, and action.

2. **The decisive, here's-the-answer type:** This chap usually is a clear, incisive thinker. He cuts through confusion to the heart of a problem. He thinks fast, decides quickly. He usually comes up with an answer that would be right if he were to carry out the project himself. He's prone to forget that you may be uncomfortable using methods which come natural to him. He rarely thinks of you as the tool with which the cutting must be done. He's likely to insist on a solution that presupposes perfect tools, perfect handling of them. He's usually unwilling to accept your natural (though imperfect) abilities as an integral part of a "right" solution. He often is not of much practical help.

3. **The "boil-the-ocean" type:** This helpmeet talks mostly in glittering generalities. He rarely is wrong as far as he goes, but rarely goes very far toward usually-controlling details. . . . Like Will Rogers' idea of boiling the ocean to meet the submarine menace. "I gave the Navy the idea," Will said, "it's up to them to figure out how to boil the ocean."

4. **The let's-explore-it-together type:** This fellow first makes you sure he understands your problem. Questioning, he often leads you to much greater clarification than you started with. Then, he asks, suggests, and "wonders" until he stimulates you to think of possibilities you hadn't unearthed for yourself. Often the "right" solution pops into your mind ere he gets around to suggesting a specific answer. Having moved into the solution under your own steam, you go away with momentum to execute your findings. . . . And you have learned something about how to explore for yourself the next time. This type helps you to help yourself—and contributes some lasting values.

. . . There are, of course, many other kinds of "helpers." Even the youngest engineer has met the four mentioned. Older hands have met up with all sorts. By experience, we each learn gradually which kind best meets our personal needs.



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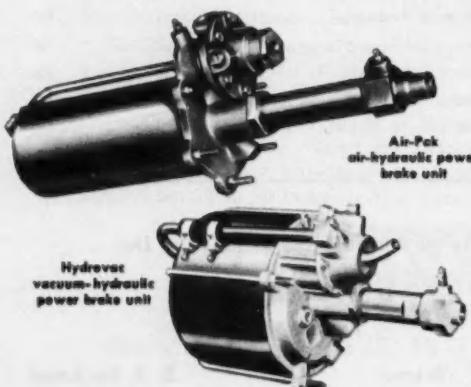
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Jersey Seashore Makes Hit As Site for Summer Meeting

"By the sea, by the sea, by the beautiful sea," some 1500 helped make the SAE Summer Meeting, June 1 to 6, one of the biggest in Society history. The salt water taffy and brisk ocean breezes at Atlantic City added zest to the technical and business sessions as well as social events. This was the first boardwalk-and-beach setting for SAE's summer get-together in 28 years, but it won't be the last. The meeting is coming back again to Atlantic City.

Top social event of the week, Gaslight Gayeties, was loaded with laughs as members and guests, bedecked as belles and beaus of the Gay Nineties, tried to identify each other. Mr. and Mrs. Bob Steeneck and their committee drew raves for their planning on this fun program. Equally well received were the technical papers and round tables, judging by the unusually high attendance and audience participation at these sessions.

Formal talks and informal idea-swapping sessions cut across the breadth of automotive interests. Specialized military needs shared the spotlight with engineering problems on civilian automotive products.

A confidential session on critical materials in aircraft jet engines played to a packed house. This off-the-record session pointed up the seriousness of alloy shortages for aircraft powerplants.

Military overtones carried over to a session on cold-weather operation. Automotive engineers were called on to come up with mechanical dogs to replace the animal canine in the North country.

The standing-room-only sign posted at the engine wear symposium showed that automotive and petroleum men still need lots of answers in this area.

Two materials—titanium and plastics—held the interest of engineers

Continued on Page 72

The European Aircraft Industry Can Aid Western Strength

Says H.R.H. Prince Bernhard

Prince of the Netherlands



WHILE you on this side, and we on the other side of the Atlantic, are steadily progressing on the long and difficult road toward the unification of the Western world, there remain the questions: "What is the actual position of aviation in Western Europe? . . . Is it important enough to be of more than subordinate usefulness to the economy and the defense of the Western world, and also to the United States?"

Excerpts from speech, "The Importance of Europe in the Cooperation of the Atlantic Countries with Respect to Aviation," given at SAE National Aeronautic Meeting, New York, April 23, 1952.

Prince's Plea May be Answered

"The United States has informed European Governments that it is now prepared to purchase complete aircraft from European manufacturers as part of its military procurement program."

This statement began a front-page story dated "THE HAGUE, the Netherlands, June 12" in the next morning's "New York Times."

The story went on to say that Netherlands officials believe that a wise policy of procurement in Europe could supply all the dollars Europe needs, provided Europe could expand commercial exports to the United States at the same time.

I shall try to give answers to these questions. The era of somewhat unstable existence of the airline companies has ended, and they have now reached the stage of economically well-justified operation and expansion. The functional services of aviation have taken a place of increasing importance in the international economy.

Spreading of production and improving distribution is the solution to this problem.

A number of European airlines using the same types of American planes and engines, have already organized a Committee of Purchasers of Aviation Materials, to ensure a proper supply of vitally important spare parts. Many of these spare parts could be manufactured in Europe for the benefit of all present and future customers of American civil aircraft industries.

There are, however, more opportunities for cooperation than there are in the production of spare parts.

I suppose that practically all big aircraft factories in the States are so busy in developing new military types that they can hardly spare design hours for work on new civil aircraft. At the same time many European factories (I must exclude England in this case) have a lot of free capacity in their design offices and prototype departments, due to lack of orders.

Could American factories not make good use of the brains and manhours that are available?

The British aircraft industry stands on a high level of production of modern types of airplanes. However, it encounters difficulties similar to those experienced by the aircraft industry here in the States. The whole industry is overloaded and works under high pressure.

The situation on the Continent is different and

probably little known in the States. Although many factories produce military aircraft (mostly under British license) there is still a large proportion of the available production capacity, including staffs of experienced engineers and skilled labor, not fully productive because of lack of orders.

I can give you a few figures for the total of four countries on the continent, members of the Association Internationale des Constructeurs de Matériel Aéronautique.

- If no new orders come off, about 5000 to 6000 machine tools will stand idle during the next few years.

- At this time, in these four countries, 4,800,000 sq ft of aircraft-factory floorspace will go unutilized. This figure will increase to more than 5,500,000 for 1953 and will be higher again in 1954.

One can easily figure out how many more people could be at work in these factories, and skilled labor is abundantly available on the Continent.

Don't you think that—besides the much needed and much appreciated flow of end-items from the States to Europe—Continental aircraft and engine factories should work to their full capacity and make a full contribution to European rearmament?

Most aircraft and engines in quantity production on the Continent are being built under British licenses. Only a few were developed on the Continent itself. Therefore I ask you another question.

What are we going to do about the contribution that the Continental design offices can make? Must they be kept frustrated? Will they—like old soldiers—never die but only fade away?

I certainly think not.

I think that we need them.

What do they have?

My answer is: brains, imagination, inventive ability, and the inherited ambition to use these attributes.

I am of the opinion that these qualities, together

with American efficiency and organizational talent, could bring about fruitful cooperation.

The Continental aircraft industry wants very much to contribute within the framework of the Atlantic Community in the field of industrial production as well as in the field of scientific development of airplanes and their propulsion aggregates.

In my opinion this aim should not be opposed, as to oppose it would be a fundamental mistake. Americans and Europeans are striving for our common ideal of realizing an Atlantic World based on sound economics and spiritual freedom for every individual. In terms of the aircraft industry this means the realization of a large production of military and civil aircraft for the defense and the economic development of the Atlantic World.

Prototypes produced by different firms should be tested on a competitive basis, by one testing center put at the disposal of our Atlantic Community.

As a European friend of yours, I should like to give a recommendation to the powerful American aircraft industry:

Don't be afraid of possible competition from the Continental European aircraft industry in relatively small markets. Contact the Western European industry as soon as possible. You will discover new opportunities for yourself, while at the same time you will strengthen the power of resistance of the Atlantic Community as a whole.

The well-known definition of sugar can also be applied to this case: "Sugar is usually a white substance which has the property of making coffee taste bitter—if not put into it." The European aircraft industry could be the element which would give a bitter taste to cooperation within the Atlantic Pact—if it is left out.

(Speech on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Fuel Tank Design . . .

... and location can be revised, CAA investigation shows, to lesson the chance of fire following a survivable aircraft crash landing

BASED ON PAPER BY Robert Schroers, Civil Aeronautics Administration

STUDY of existing data, examination of scenes of accidents as they occur, and tests made under simulated crash conditions, indicate that no design of fuel tank in use in transport-type aircraft will withstand, to any reasonable degree, the forces met with in some crashes where personnel can be expected to survive the impact.

It is also evident that no present design of tank in use is significantly better in this respect than any other.

During crash conditions some portions of the aircraft structure are subjected to lesser or greater loads than others. In one location a relatively

lower strength and lower weight tank might be satisfactory, whereas a stronger, heavier tank would be needed for equivalent protection when installed in a more vulnerable location.

It is believed that the most favorable circumstances for crash fire prevention are secured under the following conditions:

- When tank is placed outboard in the wing, where breakage is unlikely to occur, or behind a reasonably heavy spar and leading edge section to absorb direct impact.
- When an underslung nacelle is used which tends to keep the wing away from the ground.
- When tank is designed to withstand high im-

pact and deceleration loads, and when landing gear loads are not applied directly to the tank structure.

Flexible bladder tanks, free to shift in the structural compartment and possessing sufficient strength and energy-absorbing properties to resist rupture when the surrounding structure disintegrates, offer the most promising and readily available structural solution to the problem.

Fuel lines should include, at proper locations, automatic disconnect couplings, which seal the fuel in lines, when such lines would otherwise be broken due to separation of the engine from its mount, shifting of fuel tanks, or structural breakage. (Paper "Some Developments for Improved Crash Safety in Aircraft" was presented at SAE National Aeronautic Meeting, Los Angeles, Oct. 5, 1951. It was printed in full in the April, 1952 issue of SAE Quarterly Transactions. It is also available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Based on Discussion

W. C. Lawrence, American Air Lines, asked questions which were answered by Mr. Schroers as follows:

Q. How about tank retention? Could you use a brassiere or snood arrangement to retain it?

A. You've got to have a tank that is free to slip and slide.

Q. Would a spherical-form tank be the optimum?

A. A sphere is good, but there is nothing to retard it when it gets going.

Q. Would drop testing have speeded up tests, made them cheaper?

A. We didn't have a drop tower. The catapult is best. The British, who are in Indianapolis now, wish they had had a catapult to test their two types of crash-resistant tanks.

It does not follow, said Jerome Lederer, Flight Safety Foundation, that because 23.8% of fatally injured passengers were in crashes involving fire that all died of fire. In the crash of a foreign air transport, followed by fire, 23 of the 30 occupants were killed but not one died of burns or lack of oxygen. Nevertheless, every precaution must be taken to prevent the outbreak of fire. Fire does kill and does terrify the public.

Of transports intended for over-water operation, the low wing seems desirable for safety after ditching, said Lederer. The lower center of gravity also has important safety features and if crash-proof tanks can be developed, then the energy-absorbing possibilities of the low wing become more significant. Crash-proof tanks would balance the argument in favor of low wings.

The British, he said, now propose attaching portable CO₂ bottles to lines that lead to wing roots to be operated by the same crash switch which operates the powerplant protection system. They also claim to have a tank that will take up to 31g. This is obtained with a rubber-impregnated nylon fabric with an elongation of 600%.

Helicopter Expansion . . .

... is assured by military demand, but industry is faced with tough problem of cutting present excessive costs.

BASED ON PAPER BY Col. Keith S. Wilson Army Air Force

THE value of the helicopter to the military is such that it will have to be used in increasing numbers regardless of cost, but the extent of use may well be restricted unless costs are lowered. This won't be an easy thing to do since it must be granted that the military is in part responsible for the high costs. At present, the cost of initial procurement is too high, maintenance is excessive, training and experience needed for operation is too great, and the ability to meet quantity demand for both machines and parts is lacking.

It is the helicopter industry's job, if only by default, to suggest ways and means to eliminate frills, simplify design, and improve reliability of parts and components. Since one design can be made to serve many different missions, every military agency wants special features and provisions. When these are all installed it simply means that much of the equipment is merely riding around a large percentage of the time. What is needed is packaged equipment which is interchangeable and readily put aboard or taken off. Items such as hoist equip-

ment, flotation gear and de-icing equipment may only be required a few times in the life of a machine, hence to carry it around at all times simply results in putting the machine to a disadvantage performance-wise because it is overloaded.

To make the helicopter more generally useful several things are needed. From the military viewpoint there is need to develop all-weather and night capabilities. Better control and handling characteristics are wanted to reduce the call on pilot skill. There is also need for better durability and maintenance. If maintenance hours, supply problems, and operational losses are stacked up against actual flight hours, the picture is not flattering, granting the remarkable work performed by helicopters in Korea. Both machines and engines require over twice the maintenance of the fixed wing type of craft. (Paper, "Military Uses of Helicopters," was presented at SAE Metropolitan Section, Feb. 7, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Perspective Drawings

Are Easy to Read

BASED ON PAPER BY

A. L. Bradley, Creative Industries of Detroit

• Paper, "Product Drawings as Training Aids," was presented at the SAE National Passenger-Car, Body, and Materials Meeting, Detroit, March 4, 1952.

MANY manufacturers are turning to perspective views, especially for assembly and installation drawings, because they have discovered that perspective drawings are:

- Easier to understand.
- Smaller in size.
- Generally lower in cost.

The net result is that many man-hours can be saved by all who must use the drawings—the busy executive, the process engineer, the tool designer,

the tool builder, the manufacturing supervisor, and the production worker.

Equally important is the reduction in the number of errors arising from faulty print interpretation that generally results when the easier-to-understand perspective drawings are used.

Comparison of Drawings

How much easier the perspective drawing is to understand than the orthographic can be seen by

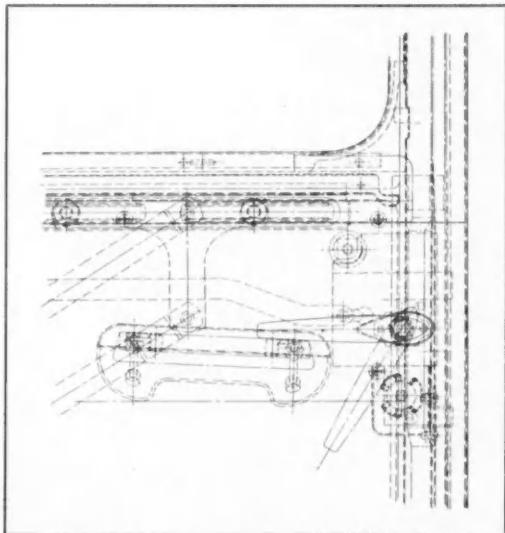


Fig. 1—Close-up of portion of orthographic drawing

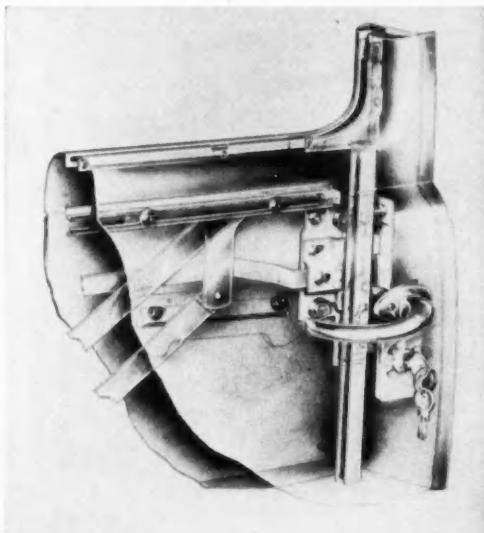


Fig. 2—Close-up of portion of perspective drawing

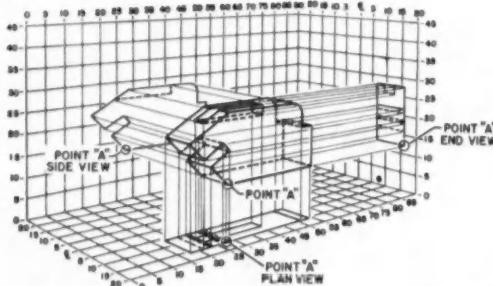


Fig. 3—View showing how points are projected on perspective grid

comparing Figs. 1 and 2. Although Fig. 1 is not too complex for an engineer to interpret, it does require time to analyze the various hidden lines and determine the relationship of the parts. Notice how clearly the perspective method brings out design details that are obscure in Fig. 1.

The first point to consider is that a perspective drawing must be *to scale* if it is to be of any value. The only practicable way of making it to scale is by the use of a perspective grid.

The principle of the grid is simple.

Visualize a cube or a series of cubes placed end to end with grid lines drawn on all their exposed surfaces, and viewed from a predetermined observer's point outside the cube. This gives a cube with its grid lines in perspective, that is, it makes a grid with built-in vanishing points on the grid lines.

Just as you can plot any ordinates of a part in three views on an orthographic grid, so can you plot any points on a part in three views on a perspective grid. If we project these points into the interior of the cube, the intersection of the points projected from side, plan, and end views becomes a point on the part. When all important points have thus been treated and connected with lines, the result is the part shown in perspective, as contained within the cube. Suitable shading brings out the highlights and results in a picture of the part readily identifiable by unskilled persons.

Fig. 3 shows how the points are projected on a perspective grid. The front, side, and plan views

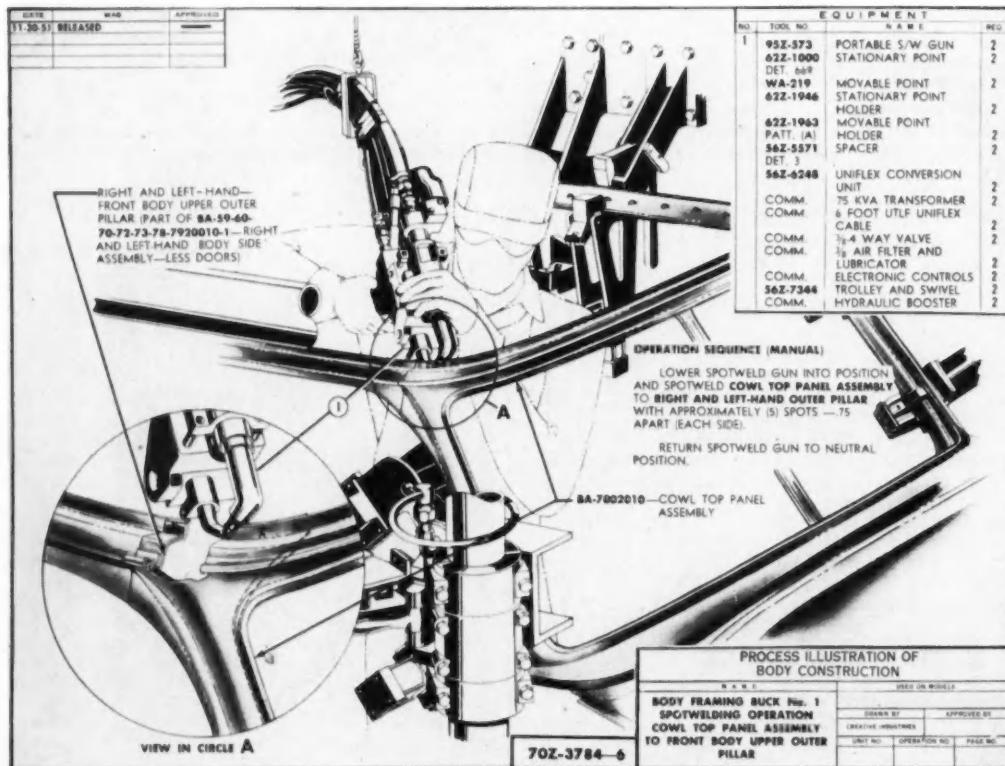


Fig. 4—One of operation sequences of automobile body assembly shown in perspective

have been laid out on the grid in their proper relationship with each other. Point A has been indicated in each view, and the witness lines show how point A projected from the three views results in point A on the perspective view. All other points would be treated in a similar manner.

Of course, only two views are needed in order to project a point to the third view, as in orthographic projection, and the side and plan, front and plan, or front and side views can be laid out on the grid according to the type of part or the convenience of the user.

Avoid Duplication of Drawings

Unfortunately, the various departments of a company often duplicate the work done by other departments.

We frequently find the product engineering division making a beautiful set of perspective assembly drawings, only to have the tooling division start from scratch and lay out the parts in perspective all over again simply because they are looking at the assembly from a different observer's viewpoint—more than likely using a different grid. The same thing applies to other departments, such as the ones required to bring out parts and service catalogs and manuals, so that by the time the program is com-

pleted similar views have been drawn three or four different times by different departments.

Since the product engineering department is generally the first link in the chain that leads to production, extra attention paid to the problem at this point will pay dividends later on.

All departments that might have occasion to make graphic illustrations should be consulted so that the drawings can be made to serve the purposes of all concerned. A short meeting of the heads of the departments involved—product engineering, tool engineering, parts and services, and advertising—should result in agreement as to the observer's point to be used.

Once this decision has been made, all product engineering assembly and installation drawings can be prepared so that the same work drawings and the same grids can be used by all departments.

The tool engineering division, for example, can use these drawings as the basis for their illustrations. They will be of great help to the process engineer, whose department can include in its manuals the type of process illustration shown in Figs. 4 and 5.

(Paper on which this abridgment is based is available in full in multolithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

OPERATION PROCESS SHEET

PART NO. 10000	PART NAME SHAFT ASSEMBLY	MODEL A-100	PART NO. 10200
MATERIAL MACH. ASSY.	DEPT. NO. A-10	OPER. NO. 10	NO. OF SHEETS 1
DESCRIPTION OF OPERATION PRESS SPACER INTO FRONT END OF SHAFT			
<p>NOTE: FOLLOW THIS SKETCH FOR MANUFACTURING—FIRST PIECE SET-UP MUST BE CHECKED BY FOREMAN</p>			
CHG. LEVEL	CHARGE	DESCRIPTION	QUANTITY
NOTES		PREPARED BY	APPROVED
NEXT ASSEMBLY 11000		CREATIVE INDUSTRIES	J.C.

Fig. 5—Typical operation of mechanical assembly shown in perspective

The Dangers Man Faces In

HOW to avoid oxygen starvation is the first and most important of the problems involved in survival at 50,000 ft and above.

Pressurized cabins—the only answer practical at present—are safe and comfortable as long as they remain integral. But there's always the possibility that they'll fail at altitude and expose occupants to the dangers of extreme cold, rapid expansion of gases in body cavities and body fluids, and powerful wind blast.

Besides the dangers associated with oxygen starvation, there are the hazards of harmful radiation, interference with vision, and—if man goes far enough—meteorites and the noxious gases surrounding other celestial bodies.

Oxygen starvation is a serious problem even at altitudes below 50,000 ft. The atmosphere at any altitude contains about 21% oxygen, but oxygen pressure diminishes with atmospheric pressure. The greater the altitude, the less oxygen forced into and through the lungs. Above 10,000 ft or so, various degrees of hypoxia (inadequate supply of oxygen to the tissues) ensue.

Table 1 expresses the average length of consciousness at various altitudes, assuming we are dealing with normal individuals under resting conditions. It will be noted that above 50,000 ft a relatively constant 10 to 15 sec of consciousness is available. From a standpoint of hypoxia, it makes little difference to what altitude above 50,000 ft we are exposed. Above 50,000 ft, consciousness time is actu-

ally a measure of the circulation time from the heart to the brain. As long as oxygenated blood courses through the brain, consciousness is maintained. If at any given moment the oxygen is completely removed from the lungs, there still remains a column of oxygen-containing blood between the heart and the brain. It requires about 12 sec for the last drop of this blood to pass through the brain.

For altitudes up to 10,000 ft, flight is safe and comfortable without supplementary oxygen. It has been found that, by adding oxygen to the inspired air in gradually increasing percentages, flights to 40,000 ft can be rendered safe and fairly comfortable. This is accomplished by increasing the concentration and pressure of oxygen in the inspired air at the expense of inert nitrogen, thus simulating the actual oxygen conditions existing at sea level under total atmospheric pressure of 760 mm of Hg. By breathing 100% oxygen to the complete exclusion of nitrogen at 34,000 ft, one can duplicate the oxygen pressure in the lungs at sea level. At 40,000 ft with 100% oxygen one is in effect at an atmospheric 10,000 ft oxygen equivalent. This, then, represents the maximum safe level of ascent for prolonged flights breathing 100% oxygen.

Above 40,000 ft atmospheric pressure is so reduced that, regardless of the oxygen concentration in the air, sufficient quantities of oxygen cannot be pushed into the lungs to maintain adequate tissue oxygenation. In order to achieve normal oxygenation it becomes necessary to increase artificially the pressure under which oxygen is delivered to the lungs.

To meet this requirement, pressure breathing equipment has been developed. The difference in pressure between 40,000 and 50,000 ft is 54 mm of Hg. To maintain safe oxygen conditions up to 50,000 ft it would be necessary to breathe 100% oxygen at increased pressures up to 54 mm of Hg. This cannot be done for more than a few minutes without damage to the lungs and circulatory system unless counter-pressure is applied to the body. It can then be seen that the maximum safe altitude with ordinary pressure breathing equipment is 50,000 ft.

The human body can withstand breathing pressures in excess of 50 mm of Hg safely if sufficient counter-pressure is supplied to the outside of the body and especially to the chest wall. This is basically the principle behind the development and use of the pressurized vest, the full pressure suit, and the partial pressure suit.

Partial pressure suits in current use enable wearers to breathe oxygen under pressures adequate to maintain consciousness at extremely high altitudes. Theoretically they can be worn safely at

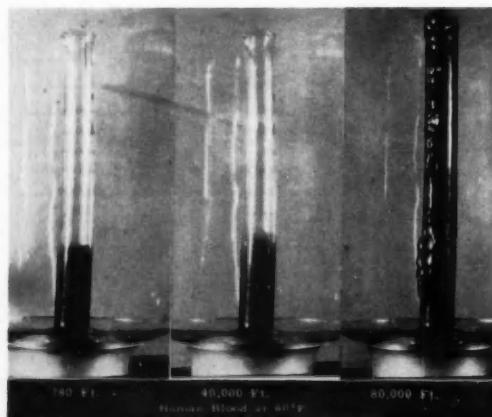


Fig. 1—Effects of altitude upon human blood

Flights Above 50,000 Ft

EXCERPTS FROM PAPER BY

Charles I. Barron, M.D., Flight Surgeon, Lockheed Aircraft Corp.

• Paper "Can Man Survive Prolonged Flights Above 50,000 Ft?" was presented before SAE Southern California Section, Nov. 3, 1951.

any altitude that can be attained by any airplane or rocket ship. The chief objection to the pressure suit is the discomfort associated with its use in the inflated state. The practical application of the pressure suit at present is its availability for emergency use—that is, to enable its wearer to descend below 50,000 ft should cabin pressurization fail above this altitude. The 12-sec period of consciousness now assumes added importance.

At the present time cabin pressurization is the sole practical means by which flights above 50,000 ft can be accomplished in safety and comfort. The principle of cabin pressurization is elementary. By compressing air as it flows into the airplane, any pressure altitude below 10,000 ft may be simulated with resultant normal oxygen breathing pressure. The advantages of cabin pressurization are numerous and obvious. Its big disadvantage is the potential hazard that will always be present with any man-occupied pressurized aircraft, the possibility of sudden decompression such as might occur by penetration of the cabin or the loss of a window.

The exact exposure temperature following decompression will depend upon the altitude, speed of the airplane, and size of the opening. Above 35,000 ft isothermal conditions are present, and a relatively constant temperature of -55°C may be anticipated. At altitudes above 100,000 ft reversal in temperatures occurs. (In addition, cockpit heating occurs on an aerodynamic basis in very-high-speed aircraft.) If it became necessary to escape from an airplane in the presence of -55°C temperatures, there would be a safe period of about 60 sec before manifestations of frostbite occurred in exposed skin.

Another important reason why routine stratospheric flights must be made in pressurized aircraft involves the behavior of body gases under conditions of reduced atmospheric pressure. All of the gases within the various body cavities, such as the intestinal tract, sinuses, lungs, and middle ear, are essentially similar in composition to ordinary atmospheric gas. In the presence of reduced atmospheric pressure the body gases expand in accordance with Boyle's Law. This involves a gas expansion of well over 5 volumes at 35,000 ft when correcting for the presence of water vapor.

At 50,000 ft an actual gas expansion of 18 volumes occurs. The higher the altitude the greater the potential gas expansion. The hazards involved are

obvious. The body can usually tolerate marked gas expansion provided the rate of expansion is slow and adjustment to the expansion can occur. In small aircraft decompression usually occurs in a fraction of a second. The amount of expansion tolerated by the lungs under these conditions may be limited to as little as 2.1 volumes.

In addition to expansion of gas, the evolution of gas bubbles must be considered. Since many gases—including nitrogen, carbon dioxide, oxygen, and hydrogen—are present in almost all body tissues in a dissolved state, it may be anticipated that with marked reduction of atmospheric pressure some of these gases will come out of solution in the form of bubbles. This actually occurs at altitudes above 25,000 ft and may cause symptoms of decompression sickness or aero-embolism. The bubbles thus formed, consisting chiefly of nitrogen bubbles, may produce a variety of symptoms depending upon the site of evolution. Partial paralysis, closure of important blood vessels of the lungs, and extreme pain in and around the joints may occur.

At altitudes above 63,000 ft the total atmospheric pressure has diminished to 47 mm of Hg, which corresponds to the vapor pressure of water under standard conditions. At this pressure body fluids literally boil away. A hint of what may occur on exposure to altitudes above 63,000 ft is given in Fig. 1.

Counter-pressure upon the body as applied through pressurized suits or pressurized cabins is necessary to prevent this phenomena. It can readily be seen that explosive decompression occurring at altitudes above 63,000 ft would be extremely hazardous.

Table 1—Consciousness Time at Altitude

Altitude, Feet	Average Time Required for Loss of Consciousness
20,000	15 Min
30,000	1 Min
35,000	45 Sec
40,000	30 Sec
45,000	20 Sec
50,000 and above	10-15 Sec

Effects of Oxygen Starvation . . .

LOCHHEED has been studying oxygen starvation (hypoxia) by stimulating altitude ascents in its low-pressure chamber. The subject in the photograph has been exposed to the pressure existing at 24,000 ft.

In one series of tests, subjects were asked to write their names, ages, and addresses in one column and their reactions in an adjacent column. The samples are records written by subjects exposed to 24,000-ft-altitude pressures without supplementary oxygen.

Studies by Lockheed investigators and others show that the average healthy man can tolerate pressure altitudes up to 10,000 ft safely and without undue discomfort. Above 10,000 ft, significant changes occur. First effects may be a feeling of well-being or even of exhilaration or elation, with defective judgment and loss of inhibitions. These changes closely simulate those produced by alcohol.

Prolonged exposure above 15,000 ft produces fatigue, loss of coordination, diminished efficiency, and—eventually—unconsciousness and death. Hypoxia is particularly insidious in that a victim may pass from initial stages to unconsciousness without being aware that anything is wrong.



<p>William L. Waller age 52 15513 Cawelti St. Van Nuys Califronia</p> <p>or</p> <p>Waiting at opening 7:50 minutes</p>	<p>1105k</p> <p>Kindest swimming Swimming slightly Water 82° or along in water feeling a little it getting diff. deep slightly</p> <p>William L. Waller age 52 15513 Cawelti St. Van Nuys Calif. Waiting 46 sec. gruffy Temperature 72° age 52 165 sec. diff. 7:50 minutes</p>	<p>Edwin L. Fish age 45 1012 Over Lane Burbank Cal.</p> <p>Edwin L. Fish age 45 1012 Over Lane Burbank Cal.</p> <p>Edwin L. Fish 113 Over Lane Burbank Cal.</p>
		<p>.86</p> <p>watering more rapid warmer slightly tugging in head pulling a lot tugging on fingers for toes in ears not long</p> <p>2 min 50 sec.</p>

ardous not only from the standpoint of hypoxia but from the standpoint of expansion of body gases.

Explosive decompression involves other potential hazards especially in smaller aircraft. The blast effect created as air rushes out of the cabin may be sufficiently great to carry along various articles of personal equipment such as the oxygen mask and helmet. Once exposed to the atmosphere, the occupants of the airplane are subject to the effects of terrific wind blasts which in turn may dislodge articles within the cockpit or partially immobilize the occupants. Wind blast effects depend upon the actual speed of the airplane.

In military aircraft a certain degree of protection against the effects of decompression at high altitude can be obtained through the use of pressure breathing equipment, pressure suits, special helmets, and protective screens.

For commercial aircraft protection is more difficult to establish. A partition of the aircraft may be necessary to prevent total decompression. Various expandible substances, such as rubber balloons, have been advocated for automatic sealing of small openings in the cabin of the ship.

At altitudes above 50,000 ft we are also faced with the problem of harmful radiation. Of potential danger to airmen are the effects of ultraviolet rays. The great majority of such rays are normally filtered by passage through the dense atmosphere near the earth's crust. In the presence of such atmosphere a tremendous increase in intensity of ultraviolet radiation is present, and must be absorbed or reflected by the skin and glass of the cabin or cockpit. In addition, special lenses and aircraft goggles must be worn.

Of more potential danger than ultraviolet radiation is the entirely new problem of cosmic radiation. At 70,000 ft altitude the daily dosage is 150 times greater than at sea level. This cosmic radiation consists of primary radiation, chiefly protons, which form secondary showers upon disruption of their nuclei with formation of protons, neutrons, mesons, and cascade rays. At altitudes between 70,000 and 90,000 ft, these rays are not considered to be dangerous, although genetic aberrations may occur.

At altitudes above 90,000 ft, a new primary component, heavy nuclear rays, has been detected. These rays, while they do not possess unusually high penetrating powers, do possess the highest specific ionization potential of any natural or artificially created atomic substance and are capable of causing extensive tissue destruction. Their effects upon the body are cumulative and similar to that of x-rays. Above 100,000 ft there is an apparent decrease in the intensity of total cosmic radiation; however, the percentage of damaging heavier nuclear rays increases. Whether these rays can be successfully reflected or absorbed by the skin of the air ship is not known at present. In fact there is not as yet complete agreement among physicists that such a cosmic barrier actually exists.

Flying at altitudes above 50,000 ft has often been described as flying atop a bowl of milk with a black lid overhead. This visual phenomenon occurs as a result of diminished reflection of light rays in the rarified air of the upper atmosphere. Direct illumination is more intense at altitude, and those por-

tions of the airplane directly illuminated by light rays will appear extremely light. Consequently, looking down towards the earth's atmosphere from a great height, intense brightness is evident due to reflection of the sun's rays upward whereas the sky overhead appears dark. This is of great importance in determining the visual acuity and depth perception of pilots and assumes added significance when flying at high speeds. It is said that a pilot flying upside down would see his instrument panel clearer than when flying in a normal upright position.

Interplanetary flights, in addition to all of the problems previously mentioned, present the possibility of exposure to radiation of unknown types and intensity, the possibility of collision with meteors, and exposure to noxious gases known to exist about various planets. Of major importance is the necessity for maintaining a suitable atmospheric environment in the space ship. Since an altitude will be reached where ambient air can no longer practically be compressed, "canned air" will have to be carried in the space ship. Theoretically, it would be possible to pressurize the air-ship initially with concentrations of oxygen to 0.6 atmosphere, or 425 mm of Hg pressure. Man can safely breathe air containing oxygen at these pressures for indefinite periods of time. It has been estimated that if each occupant of an air-ship is allowed 40 cu ft of space containing oxygen at these pressures—and means are available for elimination of carbon dioxide and water vapor—safe breathing pressures of oxygen will be available for a flight of 40 days. (At minimal calculated speeds necessary for interplanetary flights, it would require about 35 days to fly to Venus and 70 days for a trip to Mars. Supplementary oxygen would be necessary for the return trip.)

The most logical flight outside the earth's atmosphere would be to the moon. However, studies to date have failed to reveal any traces of an atmosphere about the moon. The moon's gravitational force is about 0.17 that of Earth. We may anticipate extremes of temperature within any 24-hr period. Actually temperature variations on the moon are from +135°C at noon to -200°C at night. In the absence of an atmosphere and in the presence of extreme temperatures, huge layers of dust may be expected at the surface of the moon and would create serious problems in ambulation.

Venus is the planet most similar to Earth, having approximately the same size and mass. Its gravitational field is 0.84 that of Earth. However, it appears likely that layers of carbon dioxide surround the surface of Venus, probably exceeding a thickness of one mile. There is no evidence of water vapor or oxygen in the surrounding atmosphere. The temperatures at the surface of Venus are extremely high, well over +150°C.

Finally, the planet that appears to be most accessible is Mars. Temperature variations on Mars are from -0 to -100°C. The atmosphere about Mars consists chiefly of nitrogen, with traces of carbon dioxide, water vapor, and possibly oxygen. It appears that some form of life may exist upon Mars.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

WANTED:

Clarity of Functions in Plant

WHO does what and how is still a bone of contention among engineers when it comes to performing plant layout and plant engineering functions. Organizations differ, but they face these same problems, discussions at the Plant Layout and Plant Engineering Panel showed.

Agreement came easy on what jobs have to be done in handling the plant layout and plant engineering responsibilities. Trouble is that the department that handles each job varies from plant to plant. Discussers thrashed out their function assignment perplexities and came up with proper department slots for these jobs. Their answers to several such specific situations follow:

Coordination . . . a Headache

The problem of coordination between the various groups of a plant layout—plant engineering organization appeared to be a critical one for most of the organizations represented. At least two airframe companies organize the methods group, the layout group (including equipment procurement), and the plant engineering design group under one head. Another has an industrial engineering department which is separate from the plant engineering department.

The type of organization which will do the best job depends in some degree upon the calibre of personnel available. During a period of rapid expansion, problems arise due to lack of depth in the planning organization. At such times one plant layout department depends upon production shop supervisors to help in the planning and development of their own requirements. This practice has not only alleviated overloads in the plant layout department, but has resulted in stronger, better integrated production shop supervision.

This plan is implemented by transferring shop supervisors into the plant layout department for training during expansion planning periods. This method of training obviously can't continue after production activity begins. However, effort must be expended by the layout department into, and

through, the period of production to prevent degeneration of originally good planning. To insure coordination between the layout group and production supervision, it is general practice for all production general foremen, foremen, and assistant foremen of departments involved to approve layout changes.

Area Versus Functional Responsibility

The question of functional versus area organization in plant layout and methods groups was raised. The organization of the group by function requires continual effort to achieve coordination between functional groups (methods study, layout, equipment procurement, engineering design). It was concluded by the panel that while no definite trend toward either type of organization exists, the area basis seems best. That's because of the reduction of the problem of coordination by better continuity of responsibility. The need for more competent personnel by this type of organization has made it difficult to apply.

Who Keeps Layout Boards

Whether plant layout or plant engineering should have custody of the layout boards after a layout is complete is a problem in one organization. Most discussers favored the plant layout group as the proper custodian. They reasoned that layout changes usually originate with that group as a result of time or method study and the boards should be available for revision as required.

Of course, the plant engineering group must have the completed layout to provide utilities and to prepare for the execution of the rearrangement. This group should work with the layout group to guide the layout from an engineering standpoint. One plan used successfully is to assign a plant

Engineering and Plant Layout

REPORTED BY

K. R. Waltz, Douglas Aircraft Co., Inc., Long Beach Division

• Panel on Plant Engineering and Plant Layout was held at SAE Aircraft Production Forum, Los Angeles, Oct. 3, 1951 under the auspices of the SAE Production Activity. Discussion leader was W. A. Burton.

engineering man to work with the layout man during the planning of a new layout. After a rearrangement has been executed, however, the master layout boards should remain with the layout group.

One panel member pointed out that the placement of machines (requiring plant engineering work on utility supply) is only a small part of the layout job. The arrangement of stockrooms, tool cribs, materials handling facilities etc., for an efficient work flow is the major layout problem.

The panel concluded that this question of custody emphasizes the importance of extremely close co-ordination between the plant layout and plant engineering groups.

Who Controls Space

The control of space in a plant is one of the most difficult problems confronting the plant layout organization.

In one plant, the plant layout department has responsibility for the layout of manufacturing areas, while the office manager has the office layout responsibility. In another plant the plant layout group assumes responsibility for all space assignment, but the engineering and experimental departments make their own layouts. Still another makes use of the general manager for the final decision in the assignment of space. Once assigned, the plant layout group has the responsibility for



Members of the Plant Engineering and Plant Layout Panel come to grips with a sticky problem raised in discussion. They are (left to right): H. A. Smith, assistant chief plant engineer, Consolidated Vultee Aircraft Corp.; E. F. Mellinger, executive assistant to factory services manager, Ryan Aeronautical Co.; Secretary K. R. Waltz, plant engineer-supervisor, Long Beach Division, Douglas Aircraft Co., Inc.; Panel Leader W. A. Burton, properties manager, Long Beach Division, Douglas Aircraft Co., Inc.; Panel Co-Leader H. W. Linton, chief methods engineer, North American Aviation, Inc.; and R. B. Parkhurst, director, production, Hughes Aircraft Co.

the planning and use of the area.

The panel concluded that there must be only one agency through which management assigns space and, that to fulfill this responsibility, constant vigilance is necessary to see that space is properly allocated and utilized. In most companies represented this control is vested in the plant layout department; while other departments sometimes make their own layouts, all space assignment is made by plant layout.

College or Shop Men

"What success has been had with training production shop personnel for plant layout work versus the hiring of recent college graduates with no experience?", asked one man. The conclusion: both sources are necessary because of the need for trained engineers in the field as well as for men familiar with the plant and its production operations. While competent plant layout men may be developed from shop men, formal engineering training is very desirable.

All agreed that an engineering graduate would be more valuable to a plant engineering department if he had some college courses in plant engineering. It would help shorten his indoctrination period in a plant.

Said one man from industry: Engineering courses teach a student what makes a machine work, but seldom teach him what makes it stop working.

Are Consultants Worthwhile

Little or no success with the use of outside consulting firms on plant layout could be reported by any of the airframe representatives. Naval and Air Force bases have recently started using outside contractors in this field with a degree of success in some cases. It was agreed that in the planning of a new facility, an outside firm might be used successfully. But in planning rearrangements in an existing operation, such intimate familiarity with the plant is necessary that most attempts to use outside help has met with notable failure.

How Much Space

Standards of space-per-person for use in allocating space for layouts vary from 50 to more than 350 sq ft, depending upon type of occupancy.

Office layouts allow from 50 sq ft per person for clerical work, to 85 sq ft per person for general offices where traffic with visiting personnel must be handled. Engineering offices may require 130 to 140 sq ft per person because of the space required for drafting boards, special files, etc.

Other indices of space requirements include dollars-of-product-per-month per square foot of assembly area, adopted from the auto industry, where the departmental supervision is responsible

for the volume of production per square foot. In still other cases, "space factors" have been established for each type of activity (such as sheet metal fabrication, plating, and engine repair), depending upon the volume of production required. Area-per-part has been used successfully for stockroom space allocation.

Advanced Planning

What can be done about advance scheduling of layout planning and execution? Discussion of this question brought out the point that during periods of rapid expansion of the industry, advance scheduling is extremely difficult. Reasons: uncertain procurement time for new equipment, the overloaded condition of most planning groups, and a code of reliable information. Most of those present indicated that general scheduling of layout planning and execution on a priority basis correlated with production needs has been satisfactory.

Selling Management

The importance of proper presentation to management of new layout projects is often overlooked, according to one engineer. He demonstrated a technique which has been successful at his plant.

Perspective drawings and charts are prepared to illustrate the plans to be considered. Colored charts rather than figures are used. Block layouts with colored flow lines illustrate the operation of the new layout. Presentation must be made in a positive, confident manner. Use of graphical aids presents the important points of the plan in the shortest possible time and with the greatest possible clarity, and gains the confidence of top management in the ability of the layout group to consider all phases of the problem.

Getting Teamwork

What means can be used to get plant layout, plant engineering, maintenance, and production on the same team? Response to this question indicated a universal problem. Its solution depends upon the realization by each group that its activity is only a means to an end: Sales dollars and income for the company.

One plant has succeeded in overcoming this natural friction. It set up a project committee, comprised of representatives from each group to coordinate the planning at the inception of a new program.

During a period of rapid expansion the tendency toward "empire building" must be guarded against by minimizing function and emphasizing end result.

Preventive Maintenance

Application of well-planned preventive maintenance programs in the aircraft industry is limited. One company started a study in 1946 and now has a systematized preventive maintenance program in operation.

Maintenance record cards are attached to each machine to maintain a record of maintenance costs against that machine. A tickler file establishes regular inspection periods for each machine. Inspection check sheets insure that every critical point is checked at each inspection.

With such a system, it is possible to schedule repairs on critical machines in advance so that arrangements may be made for minimum interference with production. Record cards can be compared to evaluate different makes of similar machines from a maintenance standpoint.

Evaluation of the program from a cost standpoint is difficult because of the variation of other factors during the period which also affect maintenance costs. Only four additional people were needed to take care of the record system in one large plant.

tenance cost records on portable power tools and replaces them when monthly repair costs reach an arbitrary percentage of new cost. Still another replaces all portable power tools every year.

Despite all of these policies, all agreed that during a time of accelerated production throughout the industry, other influences override the general policy, business prospects, the availability of replacements, and where the money comes from.

The usual case is that when money is available, equipment is not; and during slack periods when equipment is available for replacement programs, money is not. The present situation of expanding schedules is forcing the industry to make studies to increase machine utilization to meet schedules when new machines cannot be obtained in time.

One manufacturer is making studies of machine-operator time ratios to determine what proportion of time the operator is busy while the machine is idle, and what proportion of time the machine is busy while the operator is idle. Results of the study will permit a more efficient proportionment of operators to machines. Two other manufacturers maintain utilization charts by groups of similar machines, and another makes spot checks of utilization when a problem of need arises.

What About Costs

Most everyone intuitively feels that a thorough going preventive maintenance program pays off; but there is a lack of cost records with which to convince management. Accounting systems in use are usually designed for other purposes. They cannot be used to make direct comparisons of maintenance costs occasioned by machine breakdown during comparable periods of production activity.

One discusser pointed out that the attitude of management toward preventive maintenance is only the reflection of the attitude of others, including those who direct the maintenance program. Another felt that production people might be in favor of preventive maintenance, except for this: In some plants production time lost during a machine breakdown is not charged against production budget, but against maintenance.

The panel concluded that preventive maintenance is definitely effective in reducing down time as evidenced by successful experience on certain critical machines in most plants. How far such a program should be carried will depend on the overall economics from the accumulation of records on systems now in use.

Repair or Replace

When has a machine reached the point where it is more economical to replace it than to repair it?

One company has a team which surveys all equipment for retirement when its maintenance cost becomes high. Another maintains its own shop and personnel for overhauling machines to make them as good as, and sometimes better than, new machines available for purchase. A third keeps main-

Safe Chip Blowing

Use of compressed air for blowing chips out of machines and fixtures in the machine shop has caused damage to machines and to the eyes of shop personnel in several plants. Reduced pressures have been used, but evidence of machine damage due to the forcing of dirt into close-tolerance spaces between moving parts has been found even when air pressure doesn't exceed 50 psi. According to one production man no evidence of machine damage was found after air pressure was reduced to 15 psi in his plant.

Who Builds Equipment

When does tooling design and build special machines and equipment, and when does plant engineering design and build such equipment? One company eliminates possibility of overlapping responsibility between these two departments. It confines the activity of plant engineering to general-purpose equipment chargeable to capital or expense accounts only, and tooling to all special equipment peculiar to only one model or contract and chargeable to that contract.

Others have some trouble with borderline cases. That's because plant engineering designs and builds special contract equipment when it does not "bear on the work" to cut, shape, or form it, and when it does not depend upon engineering tolerances for fit or position. In another company borderline cases are resolved by close coordination between the two groups.

Test Bar

Background of Div. XXII's Dilemma

DIVISION XXII—Investment Castings, has been working for some time on the development of standards for investment castings. The work is intended to cover steels of automotive interest including carbon steels, low-alloy steels, stainless steels, and high-alloy steels.

(Investment casting is the process—sometimes known as precision casting or the lost-wax process—in which a wax or plastic pattern is coated with or “invested” in a plaster-like slurry. Then after the slurry has dried and formed a firm mold, the pattern is melted, vaporized, or burned out of the mold cavity.)

The first undertaking of the Division consisted in the development of investment casting standards for the carbon and low-alloy grades of steel as distinct from the high alloys of the stainless or heat-resisting classes. Since the carbon and low-alloy steels are used principally as materials of construction, physical properties become a major item of attention. The pattern for physical properties of these grades has previously been established by the SAE Recommended Practice on Automotive Steel Castings, and it therefore appeared logical to establish grades of similar classification in the investment casting standards.

SAE Automotive Steel Castings comprise three grades of carbon steels and six grades of low-alloy steels, the latter being used for the most part in requirements calling for high strength in structural applications.

From the very nature of the casting processes, it was felt that physical property standards for investment castings should be the equivalent or better than those standards applying to general automotive steel castings. To verify this, Division XXII asked as many producers as possible who were making carbon steels and low-alloy investment castings to determine test bar properties of several such grades and to submit the results to a sub-committee of the Division for classification and tabulation.

Four producers submitted test bar results and the data received are given in the accompanying tables. The results are published for the purpose of encouraging discussion and developing comments from producers and users of investment steel castings.

DESIGN of test bars for carbon and low-alloy steel investment castings has a marked effect on the test results, it is apparent from Division XXII's survey of producers. This fact is complicating establishment of a standard classification for investment castings according to physical properties.

Two general designs of bars are used:

1. Cast-to-size bars. (Gage-length section is cast substantially to size and requires no further preparation.)
2. Machined-to-size bars. (This type corresponds in sub-size to the steel foundry test bar coupon. It is fed by conventional risering and subsequently machined to test-bar form.)

Typical patterns for casting the two types of bars are shown in Figs. 1 and 2. Both types of specimens have a gage diameter of 0.252 in. and a 1-in. gage length.

Test Results

Table 1 shows the results obtained by one producer on cast-to-size bars of a carburizing grade of steel castings, SAE Grade 0022, in the annealed condition.

Table 2 shows the results obtained on a proposed grade of steel castings, Grade 0035, by two producers in both types of test bars. It will be noted that the cast-to-size test bars show greater deviation in properties and usually lower values, particularly in elongation and reduction-in-area, than do the machined test bars.

Table 3 shows similar results of two producers of SAE Grade 0050 steel, while Table 4 shows to a more marked degree the spread on a high-strength steel, SAE 0105, between the results of the two types of test specimens. Table 5 shows similar information on SAE 0150 steel as determined by two producers in two types of test bars.

Table 6 contains the results of a group of tests

Design

Influences Results on

Investment Castings

REPORT BY

R. J. Wilcox,

Michigan Steel Castings Co., Chairman of Division XII—Investment Castings of the SAE Iron and Steel Technical Committee

Table 1—Test Results on Cast-to-Size Test Bars of SAE Grade 0022, Low-Carbon Cast Steel Suitable for Carburizing

Producer	Casting	C, %	Mn, %	Si, %	P, %	S, %	Yield Point, psi	Tensile Strength, psi	% Elongation	% Reduction in Area	Rockwell Hardness, B Scale	Heat Treatment
A	B-3	0.21	—	—	—	—	34,800	64,800	22.0	40.7	50	Annealed
A	B-4	0.21	—	—	—	—	32,300	81,500	31.0	52.6	45	Annealed
Average Requirement		0.21	0.12/0.22	0.50/0.90	0.60	0.05	33,550	73,150	26.5	46.7	48	Annealed

Table 2—Test Results on Cast-to-Size Test Bars and Machined-to-Size Test Bars of Proposed Grade 0035, General Purpose Cast Steel

Cast-to-Size Test Bars

Producer	Casting	C, %	Mn, %	Si, %	P, %	S, %	Yield Point, psi	Tensile Strength, psi	% Elongation	% Reduction in Area	Rockwell Hardness, B Scale	Heat Treatment*
A	G-3	0.34	0.62	0.52	0.011	0.021	47,700	77,700	14.0	21.6	63	Annealed
A	G-4	0.34	0.62	0.52	0.011	0.021	47,400	76,400	9.0	26.3	66	Annealed
B	C-1	0.27	0.57	0.27	0.022	0.035	50,900	72,600	16.0	34.5	84	N-T 1275 F
B	C-2	0.27	0.57	0.27	0.022	0.035	51,800	74,000	16.0	33.5	84	N-T 1275 F
Average Requirement		0.25/0.35	0.70	0.60	0.05	0.06	49,450	75,175	13.8	29.0	73	—

Machined-to-Size Test Bars

B	B-1	0.29	0.58	0.28	0.025	0.030	56,000	86,000	32.0	48.0	87	N-T 1275 F
B	B-2	0.29	0.58	0.28	0.025	0.030	56,000	86,000	50.0	46.0	87	N-T 1275 F
Average Requirement		0.25/0.35	0.70	0.60	0.05	0.06	56,000	86,000	44.0	47.0	87	—

* N-T = Normalize and temper at temperature shown.

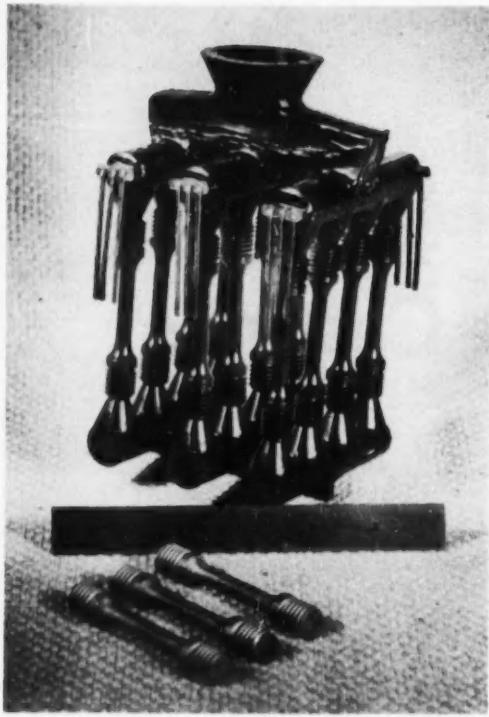


Fig. 1—Typical pattern assembly of cast-to-size test bars. Test bars are shown in front of the 6-in. rule

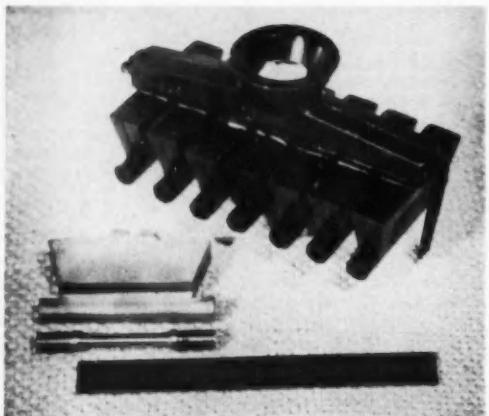


Fig. 2—Assembly of keel-bar patterns for the production of a machined test bar. A test-bar coupon and a machined specimen are shown behind the 6-in. rule

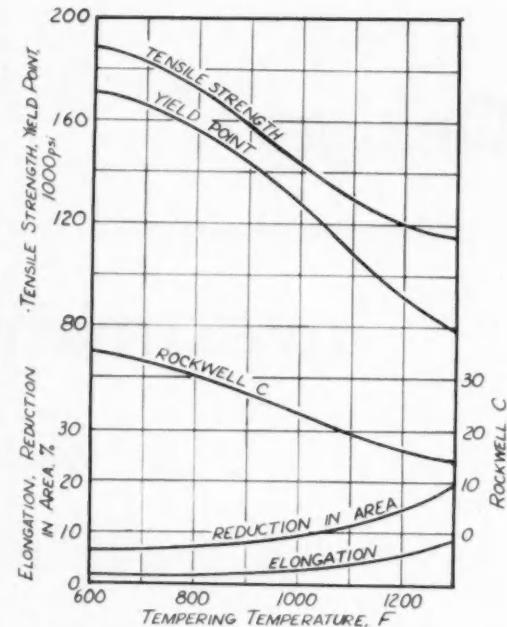


Fig. 3—Physical properties of Grade 4330 steel test bars investment cast to size by Producer A and oil quenched from 1600 F

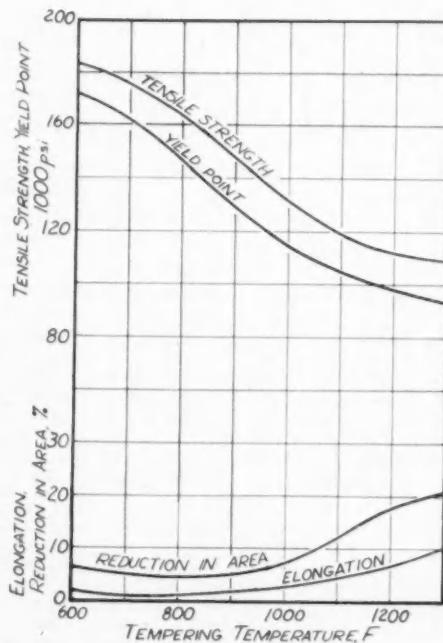


Fig. 4—Physical properties of Grade 4630 steel test bars investment cast to size by Producer A and oil quenched from 1600 F

Table 3—Test Results on Cast-to-Size Test Bars of SAE Grade 0050, Medium-High Carbon Cast Steel Suitable for Castings Requiring High Surface Hardness

Producer	Casting	C, %	Mn, %	Si, %	P, %	S, %	Yield Point, psi	Tensile Strength, psi	% Elongation	% Reduction in Area	Rockwell Hardness, B Scale	Heat Treatment
A	1-3	0.44	0.69	0.46	0.011	0.012	51,900	87,800	13.0	22.5	65	Annealed
A	I-4	0.50	—	—	—	—	50,900	85,300	10.0	25.9	66	Annealed
C	1	0.45	0.87	0.49	—	—	44,700	89,000	6.0	—	—	Annealed
C	2	0.45	0.87	0.49	—	—	50,000	94,625	16.0	—	—	Annealed
Average Requirement		0.40/0.50	0.50/0.90	0.20/0.60	0.05	0.06	49,325	89,180	11.3	24.2	66	
		Max	Max	Max			45,000	85,000	16	24	86	

Table 4—Test Results on Cast-to-Size Test Bars and Machined-to-Size Test Bars of SAE Grade 0105, High-Strength Steel Castings for Structural Purposes

Cast-to-Size Test Bars														
Producer	Casting	C, %	Mn, %	Si, %	Cr, %	Mo, %	P, %	S, %	Yield Point, psi	Tensile Strength, psi	% Elongation	% Reduction in Area	Rockwell Hardness, C Scale	Heat Treatment*
Average	D of 5	0.42	0.78	0.35	0.92	0.22	0.013	0.040	—	106,000	18.0	47.0	Annealed	
D	D-1	0.42	0.58	0.28	1.29	0.27	0.024	0.038	104,000	119,560	10.0	19.6	20	N-T 1275 F
B	D-2	0.42	0.58	0.28	1.29	0.27	0.024	0.038	—	86,500	2.0	1.7	20	N-T 1275 F
Average Requirement		0.42	0.65	0.30	1.17	0.25	0.020	0.037	104,000	104,670	10.0	22.8	20	
		Not Required					0.05	0.06	85,000	105,000	17.0	35.0	18	
		Max	Max											
Machined-to-Size Test Bars														
B	A-1	0.37	0.58	0.27	1.25	0.27	0.024	0.038	94,000	120,000	22.0	50.0	23	N-T 1275 F
B	A-2	0.37	0.58	0.27	1.25	0.27	0.024	0.038	98,000	120,000	22.0	48.0	23	N-T 1275 F
Average Requirement		0.37	0.58	0.27	1.25	0.27	0.024	0.038	96,000	120,000	22.0	49.0	23	
		Not Required					0.05	0.06	85,000	105,000	17.0	35.0	18	
		Max	Max											

* N-T = Normalize and temper at temperature shown.

from cast-to-size test bars which are unclassified. They are presented here for the purpose of completing the presentation of information available. Figs. 3 and 4 show the results in graphic form in two grades of low-alloy steel, 4630 and 4330. The curves were taken from the data supplied by Producer A and show the general relationships existing between yield point, tensile strength, elongation, and reduction in area.

Problem

The results obtained by this preliminary survey of investment-cast test-bar properties by Division XXII has made the problem of establishing expected test values a rather complicated one. This investigation as well as results obtained by others has brought out the point that the carbon and low-

alloy steels cannot be consistently cast in a sound test-bar shape of the cast-to-size design. Merrick¹ finds that the important exceptions among alloys capable of being cast sound in the test-bar shape are the carbon and low-alloy steels, and he suggests either testing production castings directly or using a test-bar design developing maximum properties with a reasonable degree of consistency.

Wallace and Berman² studied the development of 0.357-in. diameter sub-size specimens and concluded

¹ See *Metal Progress*, July 1949, Vol. 56, No. 1, pp. 53-57: "Precision Investment Casting," by Albert W. Merrick.

² See *Steel Foundry Facts*, March 1950, "Precision Investment Cast Tensile Tests of Low Alloy Steel" by Wallace and Berman.

that the long, thin shape of the standard bar did not permit the attainment of the directional solidification required for obtaining a sound gage length within a low-alloy steel investment-cast tensile bar. They propose a short 2-in. overall length bar, which, because of its shorter length in comparison to its larger diameter, can be properly fed from risers at both ends so that a completely sound bar is obtained. This specimen has a cast-to-size gage length of 1 in. and a 0.357-in. diameter. The results

reported by the investigators on 4330 steel compared favorably with those obtained from keel-bar specimens.

No specific conclusions have been drawn from the data presented in this report. It is apparent that test bar design has a great effect on expected results and that the values most seriously affected are those of elongation and reduction in area. As indicated in the accompanying box, one of the purposes of issuing this report is to encourage discussion of the subject.

Table 5—Test Results on Oil-Quenched Cast-to-Size Test Bars and Machined-to-Size Test Bars of SAE Grade 0150, High-Strength Steel Castings for Structural Purposes

Cast-to-Size Test Bars															
Producer	Casting	C, %	Mn, %	Si, %	Cr, %	Mo, %	P, %	S, %	Yield Point, psi	Tensile Strength, psi	% Elongation	% Reduction in Area	Rockwell Hardness, C Scale	Heat Treatment*	
C	3	0.25	0.72	0.47	0.97	0.25	—	—	135,500	153,110	2.5	—	28	OQ-T 1000 F	
C	5	0.25	0.72	0.47	0.97	0.25	—	—	—	154,340	2.0	—	31	OQ-T 1000 F	
B	D-3	0.42	0.58	0.28	1.29	0.27	0.024	0.038	132,000	154,800	4.0	9.4	32	OQ-T 1100 F	
B	D-4	0.42	0.58	0.28	1.29	0.27	0.024	0.038	130,300	144,000	4.0	18.6	32	OQ-T 1100 F	
Average Requirement		0.34	0.65	0.38	1.13	0.26	0.024	0.038	132,600	151,560	3.1	14.0	31		
		Not Required						0.05		125,000		8.0		22.0	33
		Max		Max		Max		Max		Max		Max			
Machined-to-Size Test Bars															
B	A-3	0.37	0.58	0.27	1.25	0.27	0.024	0.038	126,000	156,000	12.0	42.0	32	OQ-T 1100 F	
B	A-4	0.37	0.58	0.27	1.25	0.27	0.024	0.038	128,000	158,000	12.0	30.0	32	OQ-T 1100 F	
Average Requirement		0.37	0.58	0.27	1.25	0.27	0.024	0.038	127,000	157,000	12.0	36.0	32		
		Not Required						0.05		125,000		8.0		22.0	33
		Max		Max		Max		Max		Max		Max			

* OQ-T = Oil Quench and temper at temperature shown.

Table 6—Test Results on Cast-to-Size Test Bars of Various Grades of Carbon and Low-Alloy Steels

Producer	Casting	C, %	Mn, %	Si, %	Cr, %	Ni, %	Mo, %	Yield Point, psi	Tensile Strength, psi	% Elongation	% Reduction in Area	Rockwell Hardness	Heat Treatment*
A	H-4	0.34	0.61	0.49	—	—	—	96,700	114,700	6.0	18.0	91 B	WQ-T 1000 F
A	J-4	0.50	0.68	0.51	—	—	—	123,800	128,000	4.0	9.1	90 B	WQ-T 1000 F
C	3	0.45	0.87	0.49	—	—	—	140,825	166,990	2.3	—	41 C	WQ-T 800 F
C	4	0.45	0.87	0.49	—	—	—	171,465	200,635	1.0	—	46 C	WQ-T 600 F
C	4	0.25	0.72	0.49	0.97	—	0.25	—	184,120	1.5	—	45 C	OQ-T 750 F
A	P-4	0.38	0.57	0.41	—	1.77	0.22	56,400	97,600	12.0	20.2	80 B	Annealed
A	R-3	0.28	0.61	0.48	—	1.91	0.24	69,400	98,000	10.0	27.1	87 B	N-T 1100 F
A	Z-1	0.29	Grade 4630	—	—	—	—	129,500	135,000	3.0	9.9	100 B	OQ-T 1000 F
A	X-3	0.29	Grade 4630	—	—	—	—	71,700	121,800	7.0	14.4	90 B	Annealed
A	M-3	0.29	Grade 4330	—	—	—	—	39,200	105,500	10.0	23.8	84 B	N-T 1100 F
A	O-2	0.29	Grade 4330	—	—	—	—	136,700	147,600	3.0	6.1	25 C	OQ-T 1000 F

* WQ = Water Quench

OQ = Oil Quench

N = Normalize

T = Temper at temperature shown

Engine Deposits Create Fireworks

EXCERPTS FROM PAPER BY

L. L. Withrow and F. W. Bowditch,

Research Laboratories Division, General Motors Corp.

* Paper, "Flame Photographs of Autoignition Induced by Combustion Chamber Deposits," was presented at 1952 SAE Annual Meeting, Detroit, Jan. 17, 1952. This paper will appear in full in SAE Quarterly Transactions.

DEPOSITS in the process of purging themselves from combustion chambers eliminate one problem, but create another—autoignition and heavy knock. Flame photographs, taken with high-speed motion picture cameras, show that this purging action sometimes produces incandescent particles or surface areas capable of inducing autoignition.

Tests carried out in a Cooperative Fuel Research L-head engine, equipped with a quartz window head (See Fig. 1), illustrate what takes place when autoignition is induced by engine deposits.

Fig. 2 shows the deposits collected in this engine during 40 hr of running on the deposit build-up program. These deposits compare favorably with those that accumulate in full-scale automobile engines operating in general service.

After photographing these deposits, the quartz window head was remounted on the engine and the auxiliary apparatus prepared for a set of flame pictures and corresponding pressure cards. (See Fig. 1.) Flame and pressure data were recorded at 900 rpm engine speed, with a fully open throttle, spark ignition at 16 deg before TDC, a 13 to 1 air-fuel ratio, a 6.8 to 1 compression ratio, and 70-octane primary reference fuel.

Cycles from Light Knock to Preignition

During the early phases of the run, the charge in each explosion was ignited both by normal electrical ignition and by combustion chamber deposits. Near the end of the run, however, the deposits took control of the ignition process and preignition finally developed so early that knock no longer occurred. Pressure cards of eight successive explosions showing the transition from explosions accompanied by light knock to explosions resulting from preignition are shown in Fig. 3.

A comparison of these pressure cards reveals several interesting points. The intensity of the knock that occurred in each of the first three explosions is relatively light compared to the intensity of the knock in explosion 4. In fact, the knocking sound that accompanied this explosion was probably comparable to that produced by a wild ping (harsh

knock) in an automobile.

There are two characteristics of the pressure card from explosion 4 that mark it as a very heavy knock. The first is the high amplitude of the high-frequency pressure pulsations that this knock produced. The second is the rapid pressure decrease on the expansion side of the card as the amplitudes of the high frequency pulsations subside. For example, the pressure in the combustion chamber was approximately 100 psi at 40 deg after TDC. The pressure at this crank angle is appreciably lower than in any one of the other eight explosions even

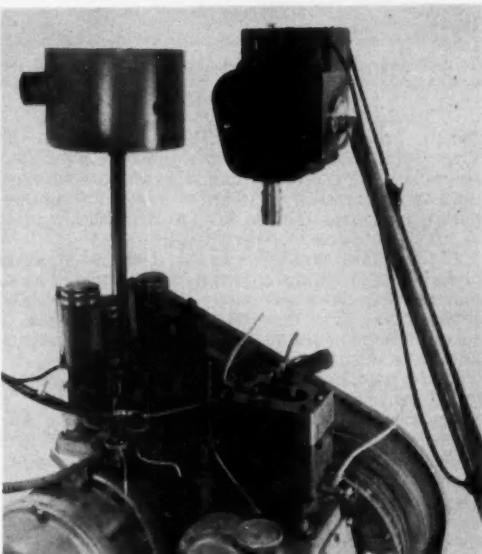


Fig. 1—Tests were carried out on a single-cylinder CFR L-head engine, equipped with a quartz window head. Two cameras, an engine indicator, and some auxiliary electronic equipment recorded pressure records and corresponding pictures of the combustion process



Fig. 2—Deposits deliberately collected during the deposit build-up program compare favorably with those that accumulate in engines operating in general service

though preignition occurred in four of them. In other words, the high frequency pressure pulsations accompanying the heavy knock were more effective than the occurrence of preignition and the completion of combustion before TDC in transferring heat to the combustion chamber walls.

The last four explosions in Fig. 3 are examples of preignition. In addition, combustion appears in all four cases to have been completed before TDC and before knock could develop. It is now of interest to examine some of the flame pictures recorded simultaneously with these pressure records.

Charts 1-6 show flame pictures corresponding to the pressure records of the first six explosions.

Chart 1 contains the flame pictures of the first explosion. The first evidence of combustion in this explosion appears in frame 10 which was exposed between 14.6 and 13.8 deg before TDC. The white spot in the lower left corner of the combustion space, however, is not a photograph of the ignition spark itself since it occurred between frames 9 and 10 when the camera shutter was closed. From this small flame, combustion proceeded normally until frame 15 was exposed. At this time, an incandescent particle was present in the right center of the

photograph or to the right of the center of the piston. At 3 deg after TDC, a normal flame began to propagate away from the surface of the hot particle. Simultaneously, another flame was initiated near the combustion chamber wall in the upper right of the photograph. Still later, at 12 deg after TDC, flames were initiated at two additional points near the combustion chamber wall. The appearance of all of these centers of ignition is attributed to autoignition induced by engine deposits prior to the occurrence of knock at 17 to 18 deg past TDC.

Chart 2 reproduces flame pictures of the second explosion. Frame 9 of these pictures contains a photograph of the ignition spark in the lower left corner of the combustion space. In frame 11 inflammation begins at another point in the lower right section of the combustion space. The flame moved out rapidly from the point of ignition over the piston and, prior to the occurrence of knock, it had swept through most of that part of the charge that is located in the so-called "squish" area. Examination of the pressure card for this explosion shows that the vibratory type of combustion associated with knock developed between 6 and 9 deg after TDC.

Explosion number 3, Chart 3, differs somewhat from the preceding two explosions although, according to the pressure card, light knock did develop about 13 deg after TDC. Except for frame 19 which was exposed just before the occurrence of knock, there is no evidence of autoignition induced by combustion chamber deposits. In frame 19, however, a single white spot of flame can be seen just ahead of the normal flame front.

Chart 4 contains photographs of the flames that developed the severe knock in explosion 4. In frame 9 the ignition spark is discernible. In addition, a small flame can be seen developing at the edge of the piston along the lower side wall of the combustion space. Flame propagated more rapidly from this point than from the normal spark discharge during the exposure of frames 10 and 11. Then, in frame 12, flame was initiated at a third point in the throat of the combustion chamber. Following this, combustion appeared to proceed smoothly until knock developed shortly after TDC.

Frame 15 shows one portion of unburned charge along the side walls of the combustion space over the intake valve and another over the piston. If local high pressures were set up in both of these areas, it is evident that a tendency would exist for waves to develop crosswise, as well as lengthwise, in the combustion space. Such a result would tend to produce pressure pulses of a range of frequencies higher than those normally observed. If this were the case, it might explain the blurred effect noted on the pressure card for this explosion.

In the succeeding explosion, Chart 5, combustion is first initiated over the intake valve shortly before the normal ignition spark would be expected to occur. For some reason unknown to the authors, neither the image of the spark nor a picture of flame initiated by the normal spark appears in these photographs. However, in frames 11, 12, and 13 a whole host of particles seem to initiate combustion in advance of the normal flame propagation. In frame 14 multiple ignition continued and completed combustion prior to TDC. Apparently these particles

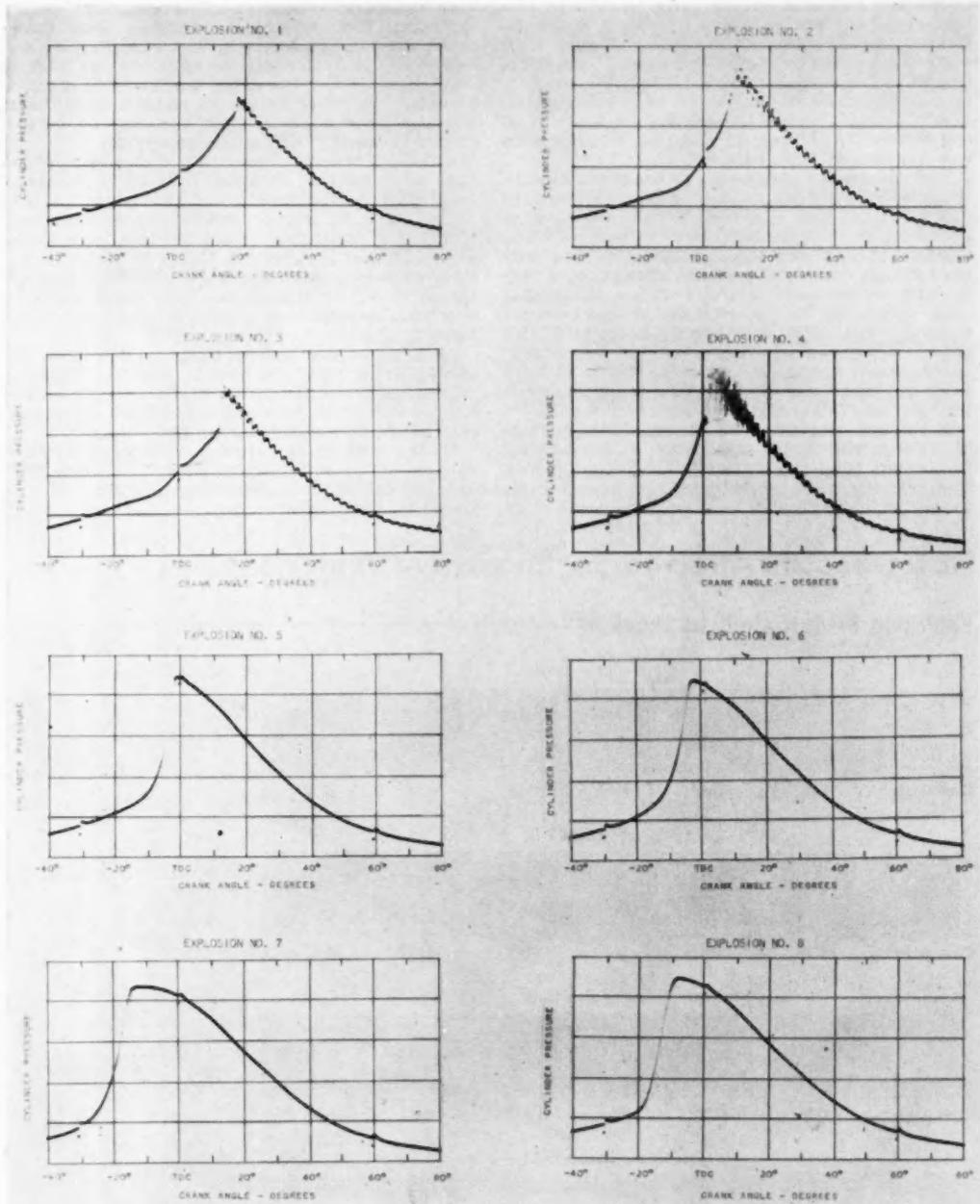


Fig. 3—Typical pressure cards of successive explosions affected by autoignition of combustion chamber deposits. They show the transition from light knock to preignition without knock

were broken loose by the heavy knock that occurred in the preceding explosion.

The last explosion of the series caught by the high-speed camera, explosion number 6, shown in Chart 6, is quite similar to the preceding one. Here again a large number of particles seemed to be effective in initiating combustion. It will be observed, however, that ignition first occurred over the piston near the upper wall of the combustion space at 26 deg before TDC (frame 6) and that inflammation was complete at 4 deg before TDC.

The appearance of a large number of particles in explosions 5 and 6 has led to a considerable amount of speculation about the reason for the dark areas in frames 19 to 24 in explosion 4 (Chart 4). The evidence that the severe knock in explosion 4 loosened a large number of particles which caused preignition in explosions 5 and 6 may indicate that these dark areas are the result of particles loosened from the wall at the time knock occurred. If this is true, it becomes necessary to explain the peculiar configuration of the dark areas in frames 19 to 24 of explosion 4. The authors have no explanation for this observation at the present time.

If the early ignition and abnormally high rates of pressure rise during combustion in explosions 5 to 8 result from the cluster of particles loosened from the walls, one would expect the engine to resume operation accompanied with light knocking

just as soon as the majority of the loosened particles had been swept from the combustion chamber. This was found to be the case. Pressure records of explosions that occurred successively after those represented in Fig. 3 showed that a light knock occurred in the sixth explosion after the one labeled number 8. Hence, the entire transition from light knocking, to heavy knock, to preignition without knocking, and back to light knocking again occurred in thirteen successive explosions.

A further investigation of this sequence of pressure cards revealed that the same cycle of events (wild ping) had occurred about 3 sec before the one shown in Fig. 3. In other words, a heavy knock had occurred 23 explosions before the one marked explosion 4 and pictured in Chart 4. In this instance, however, non-knocking preignition persisted through only six explosions. The engine resumed operation accompanied by light knocking after this interval.

Thus, it becomes obvious that, under certain operating conditions, combustion chamber deposits may distort the inflammation process in non-knocking, as well as in knocking explosions, decreasing engine efficiency and reducing fuel economy.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

How Deposits Affected Six Successive Explosions . . .

Explosion 1—Initiate light knock

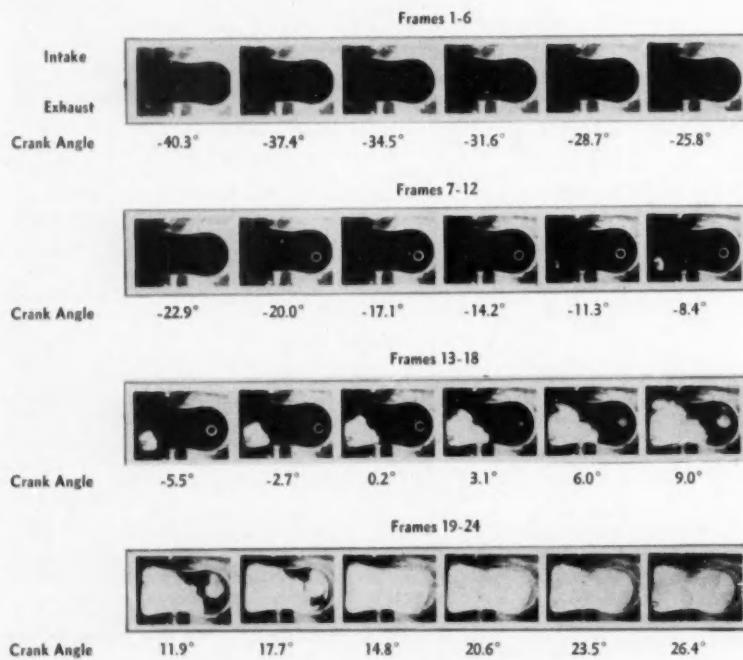
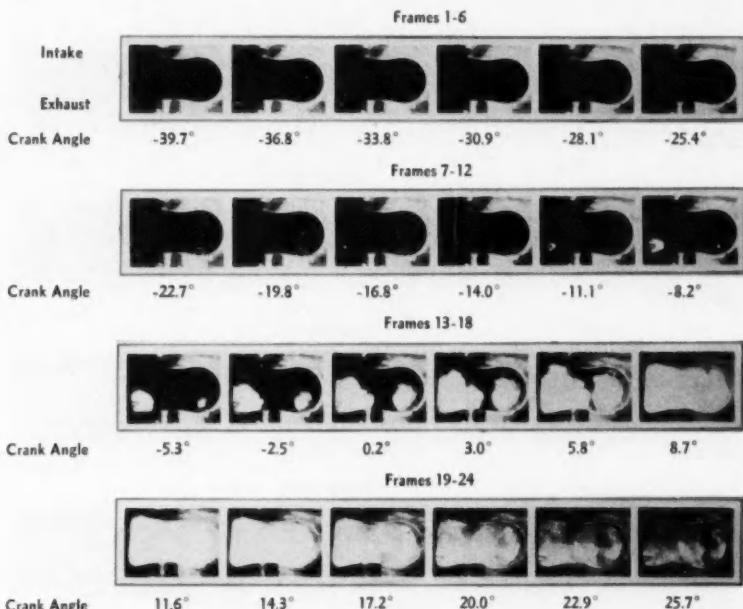


Chart 1 — Combustion initiated by both spark ignition and deposit particles gives rise to light knock at 17 to 18 deg past TDC

Explosion 2—Make it occur sooner



Explosion 3—Seem to have no effect

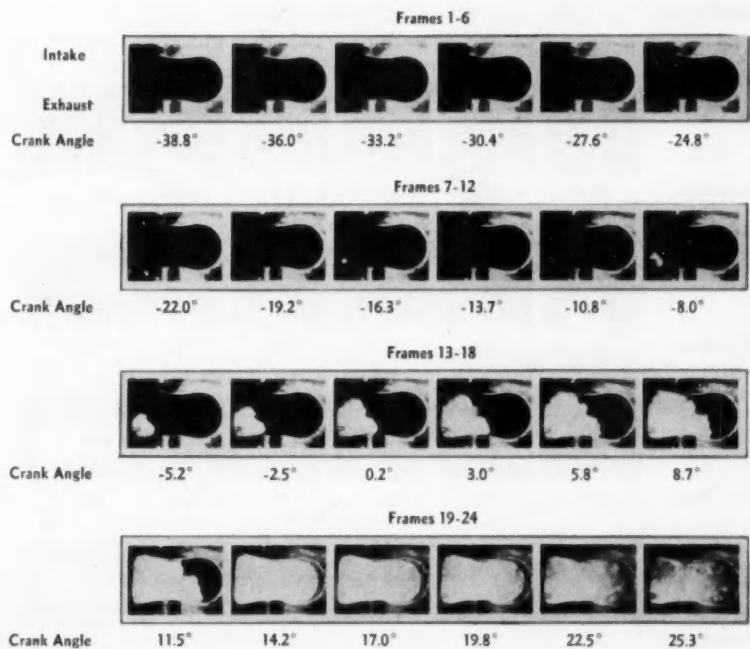


Chart 2—The flame caused by autoignition of the deposit particle swept rapidly through the so-called "squish" area, causing knock to develop between 6 and 9 deg after TDC

Chart 3—Except for frame 19, there is no evidence of autoignition induced by combustion chamber deposits in this explosion. Light knock developed at 13 deg after TDC

Explosion 4—Then cause severe knock

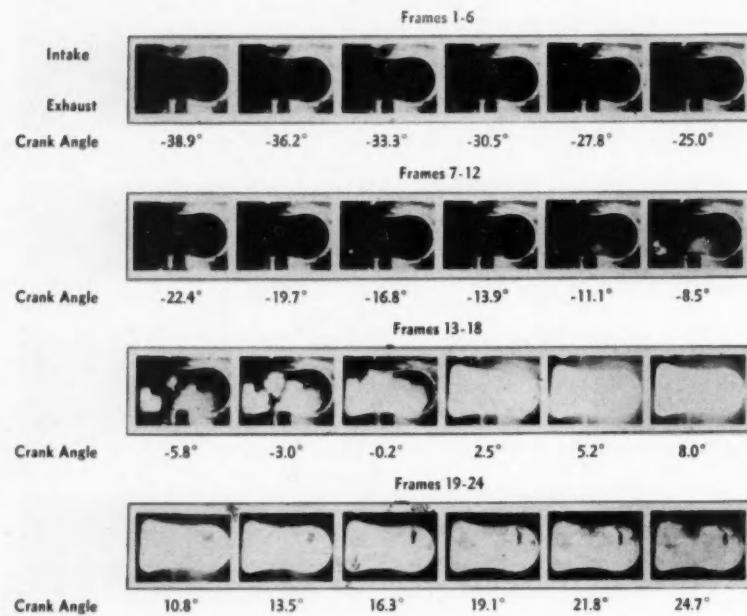


Chart 4—Flames initiated by deposits helped to develop severe knock shortly after TDC. Note how rapidly the small flame shown in frame 9 propagated

Explosion 5—Take control of ignition process

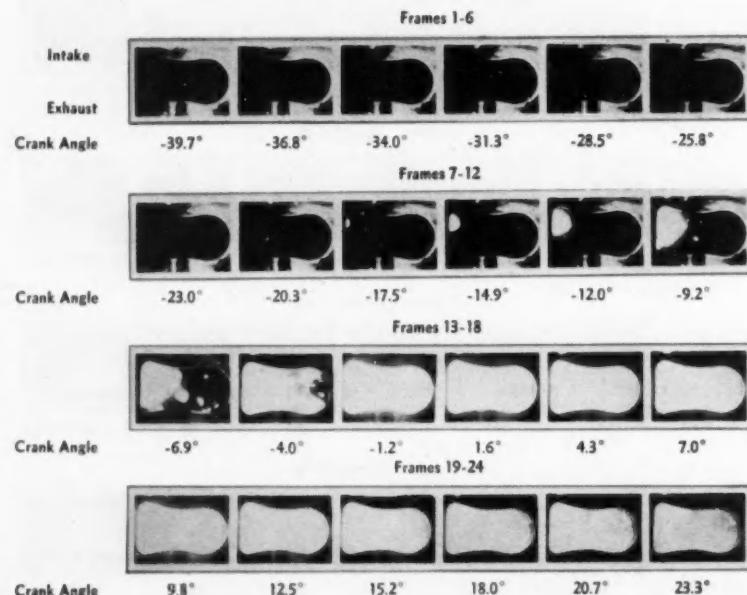
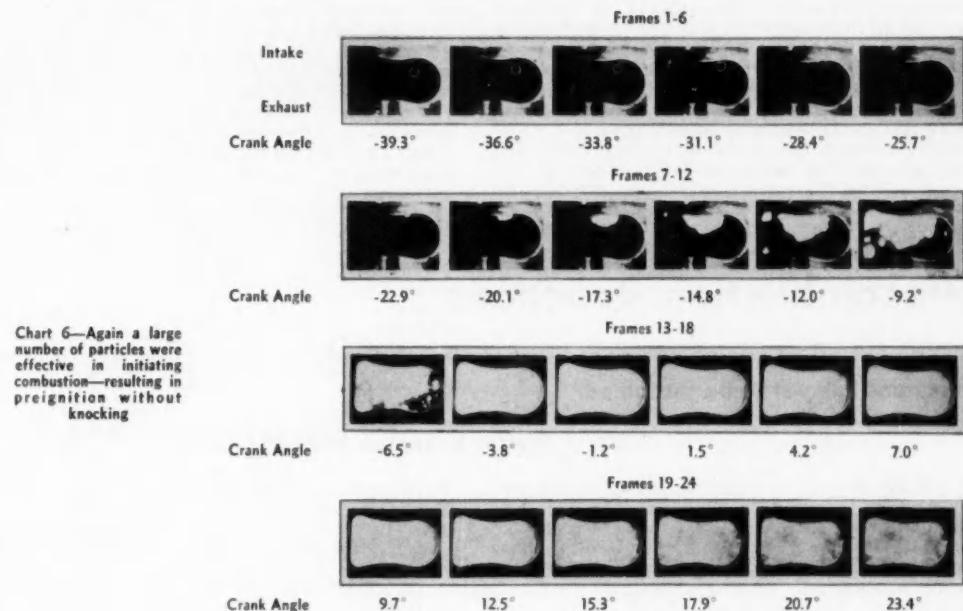


Chart 5—The severe knock in explosion 4 apparently shook loose a host of deposit particles. This cluster of potential "firecrackers" took complete control of ignition; completing combustion before TDC

Explosion 6—Bring about knock-free preignition



Based on Discussion

By B. M. Sturgis

E. I. du Pont deNemours & Co., Inc.

WITHROW AND BOWDITCH have given an excellent description of the way in which combustion chamber deposits can cause autoignition in engines. Very similar conclusions concerning the influence of deposits on preignition have been reached at the du Pont petroleum laboratory as the result of a somewhat different experimental approach.

To investigate the possibility of ignition by small detached deposit flakes, a single-cylinder supercharged engine was equipped to permit the injection of small particles of solids into the intake port under constant operating conditions.

The tests were conducted by injecting into the operating engine in one shot a small quantity, usually about 0.5 gram, of combustion chamber deposit particles or other similar materials. Preignition was manifested by marked changes in position and amplitude of the dp/dt trace on an oscilloscope. When sufficiently advanced, the preignition was accompanied by a loud knock. The relative preignition harm of the particles introduced was judged by observing the number of preignitions which occurred and the extent to which the ignition was advanced. When preignition occurred, it was ob-

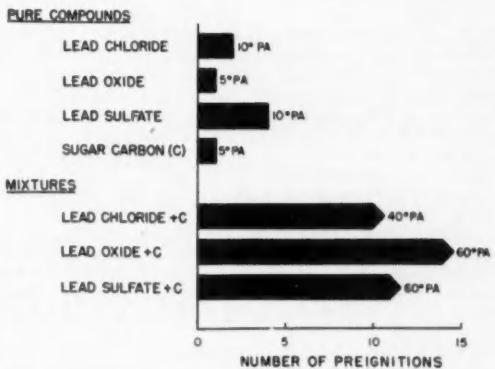


Fig. A—Neither pure lead compounds nor pure carbon cause appreciable preignition. Mixtures of the two, however, are very active. (Deposit particles ranged from 0.006 to 0.012 in. PA refers to preignition advance.)

served immediately after particle injection.

Particles of combustion chamber deposits injected in this fashion readily promoted preignition. As might be expected, the tendency of a deposit particle to cause preignition increased with its size. Very small particles were quite ineffective, but larger particles caused repeated and severe preignition. In fact, the introduction of a single flake of deposit approximately 0.1 in. in diameter usually gave rise to three or four preignitions.

Of particular interest was the observation that neither pure lead compounds of the types commonly

found in combustion chambers nor pure carbon caused appreciable preignition, but that combinations of the two were very active. (See Fig. A.) Probable explanation for the preigniting tendencies of these mixtures is that most lead salts catalyze the oxidation of carbon. This not only causes it to ignite more readily, but also accelerates the reaction rate so that higher surface temperatures result.

It is believed that unleaded fuel deposits are more harmful than pure carbon because they contain small amounts of metal contaminants from the air, from engine wear, and possibly from oil additives.

Precombustion Reactions . . .

... do not affect engine power or thermal efficiency adversely, but true nature of pre-reactions has yet to be fathomed.

BASED ON PAPER BY **Walter Cornelius and John D. Caplan** General Motors Corp.

FOR the purpose of studying precombustion phenomena in a firing engine, both cylinder pressure and radiation measurements were used. The thermal conditions of the unburned fuel-air charge during combustion were approximated during the compression stroke of a single-cylinder engine at 800 rpm full throttle operating conditions by using a mixture temperature of 300 F and retarding ignition past top dead center.

Radiation measurements indicated the occurrence of one cool flame and in some instances two successive cool flames. When the latter were detected, the maximum intensity of the first cool flame radiations and the maximum rate of precombustion reaction pressure development occurred at approximately the same time during the engine cycle. Furthermore, the variations in first cool flame radiation intensity correlated with the variation in rate of precombustion reaction pressure development, but no corresponding pressure development was detected when the second cool flame radiations occurred.

Use of TEL appeared to eliminate the second cool flame radiations while diminishing only slightly the intensity of the first cool flame radiations. It influenced the pressure development due to precombustion reactions and the octane ratings of hydrocarbon blends in the following manner:

When used to increase the octane rating of a primary reference blend the result was a much smaller decrease in pressure development than was obtained when the octane rating of the same blend was increased a like amount by increasing the concentration of iso-octane.

The increase in octane ratings of hydrocarbon blends obtained by adding 1 ml per gal of TEL varied directly with the magnitude of the pressure developments determined for unleaded blends. On the other hand, TEL's effectiveness in suppressing the precombustion reaction pressure developments and in increasing octane ratings diminished when its concentration was increased above 1 ml per gal.

The studies indicate that precombustion reactions take place in automotive engines on the road (operating with mixture temperatures below 140 F) after ignition during combustion rather than before ignition during the compression stroke. Hence, no losses in power and thermal efficiency should occur on the road as the result of cylinder pressure developments due to precombustion reactions taking place during the compression stroke and prior to ignition.

(Paper, "Some Effects of Fuel Structure, Tetraethyl Lead, and Engine Deposits on Precombustion Reactions in a Firing Engine," was presented at SAE National Fuels & Lubricants Meeting, Chicago, Nov. 1, 1951. It will be printed in full in SAE Quarterly Transactions. It is also available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

Based on Discussion

A. O. Melby

E. I. duPont de Nemours & Co.

THE authors' investigation has shown the existence of a second and less intense cool flame which is suppressed by TEL. This second flame reaction may have an important relationship to the knock process and deserves further investigation. Our studies indicate that TEL has a small effect on the first cool flame limit. The principal effect appears to be a retardation of the cool flame reactions, thereby necessitating higher pressures for auto-ignition. We found that a significant portion of the TEL is decomposed prior to the occurrence of the first cool flame. Therefore, the decomposition products would be available for reaction throughout the cool flame processes.

The correlation between the extent of precombustion reaction and TEL susceptibility pointed out

by the authors is of particular interest. We have found that a number of hydrocarbons autoignite in a motored engine without first passing through a cool flame stage. This behavior has been shown by diisobutylene, dicyclopentadiene and some aromatic hydrocarbons such as benzene, toluene, ethyl benzene and cumene. Most of these are highly knock resistant, hence the requisite conditions for autoignition are comparatively severe.

E. S. Corner

Standard Oil Development Co.

STUDIES made by our company have shown TEL to be completely destroyed in combination with

n-heptane under the same conditions where it was only 50% destroyed when added to toluene. These data indicate that some TEL reacts directly with intermediates (radicals or oxygenated compounds) formed by prereacting compounds and thereby probably controls chain-branching reactions which eventually lead to knock. This may explain the apparent relationship between the extent of pre-reactions in the absence of TEL and the improvement in antiknock quality obtained by TEL addition. This mechanism would also explain the fact that TEL has a relatively small effect on the temperature at which pre-reactions are initiated. In the actual combustion flame, oxides of lead may be compounds tending to suppress knock.

Tractor Valve Life . . .

. . . can be improved by using data gleaned from valve train studies of car, bus, and truck engines.

BASED ON PAPER BY K. L. Pfundstein and J. D. Bailie Ethyl Corp.

VALVE-LIFE data for tractor engines are hard to obtain. Operators' records are far from adequate and valve life normal variation is such that the number of tests needed to reach any worthwhile conclusions is beyond the means of most tractor experimental groups. Clues to guide work with tractor engines can come, however, from studies made on car, truck and bus engines.

Engine Design vs Valve Life

Studies show that there is no correlation between accepted base fuel inspection data and valve life; that is, the effect a particular fuel may have cannot be predicted by any known physical or chemical test. Nevertheless, it is well recognized that certain combinations of fuel and oil can affect valve performance, that additives contribute to the complexity of the fuel and oil consumption. And it has been shown that the effects are not consistent and depend on engine design and operating conditions.

In general, the greater the load the shorter the valve life. Constant speed and load operations appear to be the most severe, particularly wide open throttle conditions. Tests also reveal that some engines have the desirable characteristic of being tolerant to variations in fuel, oil, and operating conditions.

When valve life in a given engine is poor, evidence pointing to the cause can usually be obtained by inspection of failures. There are four categories: sticking, burning, breakage, scuffing or excessive valve train wear. The primary cause is sometimes obscured. Valve burning or breakage, for instance,

may occur as a result of distortion of engine parts. Examination of each component of the valve train frequently provides the tip-off as to the fundamental cause of distortion.

Tests show that the valve life of existing engines can be extended greatly by design modifications, by the selection of suitable materials, and by application of valve rotation. Furthermore, such measures can improve the tolerance of engines to factors affecting valve life. (Paper, "Factors Affecting Tractor Valve Performance," was presented at SAE National Tractor Meeting, Milwaukee, Sept. 12, 1951. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

Based on Discussion

Vincent Ayres
Eaton Mfg. Co.

VALVE LIFE in tractor engines as a whole has been inadequate. Problems that have arisen may have been due to use of inferior material, or to inadequate design. Changing the use of an engine by requiring higher outputs, higher speeds, or other increased performance may render an otherwise well designed part unfit.

Valve gear deflection is worthy of investigation. It may not be the root of any present trouble, but it could be the limiting factor should a manufacturer decide to improve his product. The valve gear deflection of the valve and tappet comprising the L-head valve train is very low, whereas with an

overhead valve engine it might be 10 times higher. If it were decided to increase valve sizes, the additional weight on the overhead valve train might be sufficient to increase deflection to the point of creating bad valve gear vibration. Conversely, a reduction in valve size might be permissible, which would favor the valve gear. Valve gear vibrations are excited and controlled by the cam. This is vital to remember when changing valve lash settings to accommodate different engine operating conditions, or valve steels with different expansion coefficients.

J. A. Newton
Thompson Products, Inc.

WHEREVER an alternate steel is intended to be used as an improved valve steel, there may be other factors to be considered regarding the installation of these materials to operate properly. For example, the coefficient of expansion of XCR is

somewhat greater than XB and Silchrome No. 1, while that of the austenitic group is still greater than that of XCR. For this reason changes in material must be accompanied by lash studies to obtain clearances that will prevent valve burning.

Valve rotation is another item requiring further emphasis. Normally valve rotation extends valve life 2 to 5 times and very frequently 10 times or more. Rotation has been gaining steadily in popularity, first in the heavy duty truck engine field, and more recently in engines designed for other types of service.

Although not discussed by the authors, it seems worthwhile commenting on valve and seat specifications for Butane conversion engines where experience has shown valve operation to be quite severe. We recommend the use of hard inserts and hard-faced valves, with or without rotation, for exhaust valves. Intake valves frequently run in the range of 1200F, and it is preferable to specify XB as the intake material.

Transport Helicopters . . .

... hold high promise for short haul traffic. Have been selected as best suited in 10 year plan to link New England.

BASED ON PAPER BY Joseph Garside E. W. Wiggins Airways, Inc.

MODIFIED DC-3 aircraft have done well in short haul service over many areas, but for New England, which has a tremendous volume of traffic within its borders, the helicopter seems best suited. In this territory, surface transportation is made devious by terrain and slowed by clogged and inadequate highways. Air transport has not yet dented the short haul field. Up to 100 miles, existing air service generates only about 100 passengers per 1000 capita annually as contrasted with the rail service figure of about 2300.

A 10-year plan launched by Wiggins Airways calls for linking up New England industrial, educational, and recreational centers by helicopter. Next year, two 8-place single-engine craft will be put into service to aid in figuring possibilities and to serve as a measuring stick for an expanding service. Between 1955 and 1957 these are to be replaced with multi-engine equipment, and within two years from date of their delivery, it is hoped to have all fixed wing craft replaced.

Small Ports Save Money

On the debit side of helicopter use is the higher cost per airframe mile due to low cruising speed. The only way to cut this cost is to improve accessibility of component parts, provide for their quick

replacement at overhaul periods and increase the life of moving parts. On the credit side is the low cost and small acreage required for landing sites, also, the relative lack of noise. Airports can be well placed and quickly moved. Helicopters can operate in much worse weather without landing aids than can the fixed wing craft. However, some aids to navigation will be required.

Envision 30-Passenger Craft

Direct costs for a hypothetical multi-engine, 30 passenger helicopter have been estimated at \$1.20 per mile. Indirect costs would appear to be 52¢ a mile, making a total of \$1.72. Calculating passenger fare is complicated, but it is figured at 20¢ a mile for the first 10 miles, 10¢ for the second 10 miles, and 6¢ a mile thereafter. The expected yield is 8¢ per passenger mile. On this basis the break-even load factor over specific routes should be about 65%. Once lines are established, costs will force a change in method of ground station operation and the handling of sales and tickets. (Paper, "Helicopter Airline Operation in New England," was presented at SAE Metropolitan Section, Feb. 7, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

Magnesium Goes Automotive

EXCERPTS FROM PAPER BY

J. D. Hanawalt and G. K. Glaza, The Dow Chemical Co.

• Paper "New Applications and Developments of Magnesium Alloys in the Automotive Industry," was presented at SAE National Passenger Car, Body, and Materials Meeting, Detroit, March 5, 1952.

Magnesium isn't new to the automotive field, but its potential usefulness has grown to new levels. That's because of cost reductions through developments in metal-working techniques that exploit the material's unique properties. Product research with the metal also

is opening new applications.

This is a progress report on these two phases: (1) up-to-the-minute fabricating methods for magnesium, and (2) the status of automotive applications for the metal.

I. Manufacturing Methods

1. Die Casting

The increasing number of parts steadily being converted to die castings is good evidence of the economies of the manufacturing process, acceptability of the product, and recognition of the utility of magnesium die castings.

Most magnesium die castings are produced on a conventional cold chamber die casting machine. With the exception of the metal melting equipment, both the machines and dies used are practically interchangeable with those used for aluminum die casting.

The melting of magnesium is done in a non-oxidizing atmosphere, usually sulfur dioxide gas. Casting temperatures range from 1150 to 1250 F. Metal injection pressures commonly lie between 2000 to 15,000 psi.

In amenability to intricate coring, magnesium die castings rank between zinc, which is the best, and aluminum. Required draft is greater than zinc, but less than aluminum.

Magnesium castings do not have as great a ten-

dency to solder or adhere to a die as do aluminum die castings. Consequently, in comparison with aluminum, die coating solutions are not necessary, and the need for die lubrication is decreased.

This chemical affinity of molten aluminum for iron or steel presents handling problems which require special materials. However, magnesium can be transferred in the molten state through steel pipes. It would appear to be more readily adapted to automatic ladling and metal handling.

The total heat content of a given die casting is lower in magnesium than in zinc or aluminum. Therefore, with equivalent machines and dies, a magnesium casting will cool faster, can be removed from the die sooner, and will show a higher production rate.

As Cheap as Iron

Lowered costs through the use of magnesium die castings are often easy to show. From reliable sources, cost figures for automotive iron castings are in the 10 to 15¢ per lb range, with some complex castings being higher. Most of the applications

which have been tested, or are in production, indicate that magnesium could be substituted for iron at an equal thickness, or redesigned to the same total volume of an iron casting.

With a four-to-one ratio in weight between magnesium and iron, the cost of an iron casting approaches or is the same as the cost of a magnesium die casting. There is a further gain to be had on parts which have low operational stresses. A magnesium die casting can have reduced wall thicknesses, while casting limitations may make a similar reduction in cast iron impossible.

The opportunity for saving broadens even further with complex iron castings requiring any appreciable amount of machining. Not only can more complex and accurate coring be accomplished in die cast magnesium, but many surfaces can be cast to size which would otherwise have to be machined.

When machining is necessary on a magnesium die casting, one machining cut or pass will—except in rare cases—meet tolerance requirements. This is an obvious advantage over the separate rough and finish machining operations which are often required on an iron casting.

2. Machining

Magnesium is considered the easiest of all metals to machine. This property often influences its use in parts where a large amount of machining is necessary; in these cases weight saving may not be of primary importance, and the cost of the magnesium part is higher than the competitive material before either is machined.

Magnesium alloys are adaptable to any standard tooling set-up with little modification. They can be machined at higher speeds and feeds than any other metal. With power consumption as a basis of machinability comparison, magnesium requires only one-half to two-thirds the power required for brass and aluminum, one-third that for cast iron, and one-sixth that for steel.

A Michigan manufacturer has recently begun using magnesium permanent mold castings for a convertible automobile top folding mechanism.

A reduction in part cost over the replaced permanent mold castings is obtained through a 35% saving in machining cost, even though the rough casting and surface finishing costs for magnesium are slightly higher. The machinists in this plant prefer to work with magnesium. A messy coolant is not required to eliminate excessive tool wear or to obtain maximum production in their operations.

A switch to magnesium from cast iron for belt pulleys by a Chicago concern resulted in a saving of machining time as follows:

- a. Shop Time Required for Cast Iron Pulley
 - 64 min machining
 - 5 min balancing
 - 69 min total
- b. Shop Time Required for Cast Magnesium Pulley
 - 24 min machining
 - no balancing required
 - 24 min total

Cutting tools stand up well on magnesium. An Eastern manufacturer of machine tools reports that the life of high-speed cutting tools, when machining magnesium, equals the life of carbides when machining other metals.

One of the leading automobile manufacturers has observed that cutting tools last three to 10 times longer when machining magnesium than when machining aluminum under similar conditions. They have increased tap life 10 to 15 times on die castings that have been switched to magnesium.

The machine shop superintendent of Thompson Products, who machines great quantities of magnesium and aluminum jet engine parts, has said this: While magnesium and aluminum are machined at the same speed in our shop, the carbonyl cutting tools have to be resharpened every three or four days while cutting aluminum, but only every three or four months while cutting magnesium. The saving in downtime for tool replacement is a powerful argument for magnesium in this shop.

During World War II, Goodyear Aircraft Corp., who turned out large quantities of magnesium aircraft wheels, conducted studies that revealed that magnesium wheels could be processed through their machine shop at a rate double that of other possible materials.

Excellent surface finish is obtained because there is no tendency for the metal to drag or tear. Magnesium's free cutting action produces well-broken chips which do not obstruct the cutting tool or the machine. Finishes equivalent to ground surfaces on brass printing cylinders can be obtained on magnesium by fine machine cuts, eliminating the expensive grinding operation on this application.

3. Electroplating

Electroplating magnesium is a new development that seems certain to expand the field of application of magnesium die castings in the automobile industry, since a large percentage of automobile hardware is electroplated.

Now that recent advances in the die casting art have made magnesium castings competitive, and a commercial process for electroplating these parts is available, the path is open for the production of plated automotive die castings.

Electroplating of magnesium has been used on production parts in other fields for several years. The hard chrome plating of magnesium photo-engraved printing plates has increased the number of impressions obtained per plate from 10 to twenty-fold.

An electroplating process patented by Dow Chemical is available for commercial use.

The key step in the process for magnesium is the formation of a base coating of zinc. Steps involved are simply an activating pickle and a zinc immersion coating of about 0.0001 in. thick. The parts can then be processed through standard copper, nickel, chromium, or other metal baths. The most protective coatings are obtained by using the complete copper-nickel-chromium system; but on hardware requiring very little corrosion protection, some plating schedules with fewer steps may be used.

Plated specimens exposed in a rural, severe in-

dustrial, and seacoast atmosphere indicated that after one year's test with plate thicknesses of 0.002 in., magnesium is equal to zinc in resistance to corrosion.

Panels were exposed for nine months in Pittsburgh. Some attack is evident on all panels but cleaning will remove all traces of it as far as general appearance is concerned. In a warm seacoast atmosphere at Miami, there is very little evidence of attack on any of the panels.

When plate thicknesses are reduced to 0.00125 in., slightly more corrosion occurs in one year at Pittsburgh. Fewer areas are attacked on the magnesium than on the zinc, but the pits are slightly larger. At Miami after 12 months' exposure, the panels are similar to those which had 0.002 in. of plate.

Extrapolation of the test data indicates that a plate thickness of about 0.0008 in. is desirable for interior automotive applications. In all the tests the total plate thickness was made up of 0.0005-in. copper with the balance nickel and a chromium flash.

4. Forming and Drawing

Techniques for forming and drawing magnesium have been brought to a high state of development in the past few years, mainly through control of temperature.

The greater proportion of forming operations on magnesium alloys is done at elevated temperatures because formability at room temperature is limited. A certain amount of cold forming, however, is possible. Both hot and cold forming are done with conventional forming equipment. By applying heat, the ductility is increased to such an extent that greater deformations are possible on magnesium than in other metals at room temperature. This also holds true when these metals are drawn at the same elevated temperatures as the magnesium.

When shop personnel have become accustomed to the advantage of hot forming magnesium, they usually find that it becomes an asset. For instance, many press-formed parts switched from steel or aluminum to magnesium, which formerly required several die stages with intervening anneals, have been made in one single hot operation from magnesium, eliminating costly tooling.

Deep-drawn shells with reductions up to 65% are normal, and reductions up to 73% have been shown to be possible.

Springback, troublesome at room temperature, is also minimized at elevated temperatures. Rectangular boxes with ratios of depth to corner radius of 12 to 1 are common and even have been drawn with a ratio of 20 to 1 in one operation.

Magnesium alloys were first deep drawn back in the mid 1930's. During World War II the techniques were improved to the point where a large assortment of hemispherical, parabolic, rectangular and various odd shapes were drawn in production quantities. Since then, deep drawing of magnesium for commercial and military applications has continued in a number of sizable shops in various parts of the country.

Parabolic reflectors for radar equipment as large as 30 in. in diameter are being drawn in one opera-



Fig. 1—This parabolic radar reflector was drawn in one operation in the die at left. The holes were pierced after forming



Fig. 2—A commonly found mechanical press produced this waffle grid stiffener for aircraft wings

tion. Fig. 1 shows one such parabola with the die set up in a hydraulic press. These holes were pierced after forming.

The waffle grid stiffener in Fig. 2 is being shallow-drawn in one hot operation on a mechanical press formerly installed in a press shop serving the automotive industry. These waffle grids, used as stiffener panels on the B-36, are drawn hot from blanks 30 x 59 in. in one operation. To date over 100,000 have been produced.

Dies for forming magnesium are heated by gas burners, electric cartridge heaters, and hot fluid heat exchange pipes cast integrally in the dies. Gas burners are used most extensively because their simplicity, ease of attachment to irregular dies, and low fuel cost make them the most practical and economical.

Lubricants, such as colloidal graphite, are available which will give the required lubricity at elevated temperatures.

Other forming operations—such as spinning, stretch forming, drop hammer forming, and press

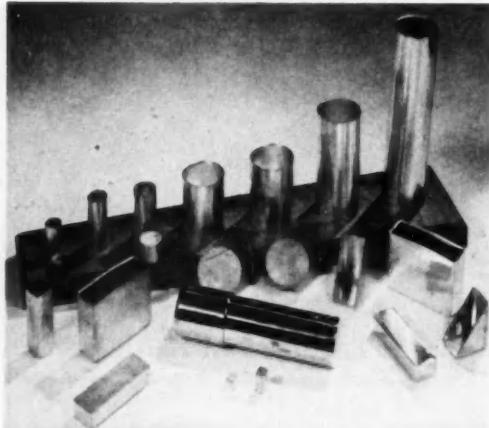


Fig. 3—These are some of the magnesium parts that can be made by impact extrusion

brake bending—are currently being used on magnesium alloys by many fabricators around the country. Techniques and equipment are similar to those used on other metals with provisions made for application of heat.

5. Impact Extrusion

The adaption of the impact extrusion principle to magnesium is a recent manufacturing development.

Small, symmetrically shaped, tubular parts are made by placing a hot, lubricated slug of magnesium of the required volume into a heated die and applying approximately 40 tons per square inch pressure with a punch. The clearance between the punch and die determines the wall thickness of the part.

Slugs for this process are sawed automatically at rates up to 60 per min from extruded bar stock of the required shape.

The sawed slugs are tumbled to remove any remaining kerf and to apply a thin, even film of graphite lubricant. The graphite is later removed from the finished parts by a caustic soak and an acetic nitrate pickle.

Magnesium alloy parts are made at an operating temperature of 450 F and at speeds up to 100 parts per minute.

Round, square, and rectangular parts, such as shown in Fig. 3, have been made. Ribs, flanges, or bosses could be incorporated in the part as with other metals that are impact extruded.

From this selection of parts it seems reasonable that some magnesium impact extrusion applications may be found in the many automotive parts such as knobs, junction boxes, shields, housings, and structural clips which are used to hold cables and wires in place.

The main use for impact extrusions of magnesium at present is the manufacture of magnesium battery cases in the various standard cell sizes.

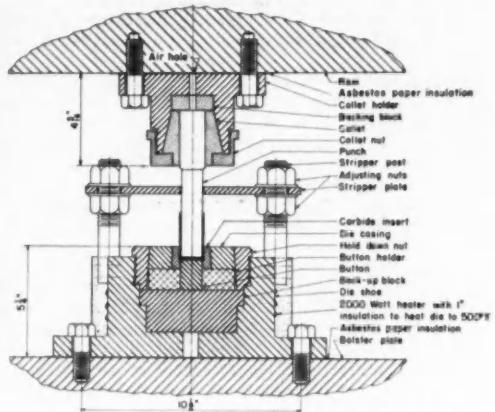


Fig. 4—It takes this kind of a tooling setup to produce magnesium impact extrusions

Any sturdy, well-guided press having sufficient capacity and stroke, such as found throughout the automotive industry, could be used for producing magnesium impact extrusions.

An example of the tooling used is shown in Fig. 4. Tool steel or carbide dies are used with die life estimated at 200,000 and 10,000,000 parts, respectively. Close tolerance on parts may be held by careful alignment of tools, short punches, close alignment of the press ram, low clearances between the slug and die, and proper lubrication. Plus or minus 10% of the nominal wall thickness is considered a good production tolerance.

6. Joining

In the field of lightweight welded assemblies, magnesium offers unique advantages. It is easily welded by most of the common processes. The metal has found widespread acceptance in arc welded structures in materials handling, aircraft, and electronic equipment.

The expansion of magnesium usage in these fields has been in a large part a result of two factors:

1. The weldable characteristics of magnesium make arc and spot welding of all types of joints simple and economical.

2. The joint strength efficiencies on magnesium alloys are very high, ranging to well over 90%.

Welding Magnesium

A good example of the possibilities for large arc welded, magnesium alloy vehicles is the experimental 6000-gal, all-magnesium, welded trailer-tank built by Butler Mfg. Co. of Kansas City, Missouri. This tank was fabricated from magnesium plate ranging in thickness from 3/16 to 1/4 in. Welding was done with the argon gas shielded-welding process. See Fig. 5.

This tank was service tested approximately two

years and its performance has compared favorably with other experimental tanks.

High-quality spot welds in magnesium are easily made with the better types of electronically controlled machines, such as the stored energy and new three-phase types having close control of weld current, pressure, and time. Production chemical cleaning methods are available for surfaces to be spot welded which give low and consistent surface resistances. Spot weld strengths are adequate to give joint strengths of high efficiency comparable to spot weld joints in other metals.

Enough work has been done with flash welding to conclude that this economical joining method is practical on magnesium alloys. Joint efficiencies of 90 to 95% have been obtained in experimental tests and the process awaits applications where production rates are great enough to justify the tooling costs.

Adhesives Attractive

The new structural adhesive bonding techniques, while offering many advantages in general, appear to be uniquely favorable in many respects to magnesium fabrication. The following advantages are worth careful study:

1. Great increase in fatigue life is obtained through minimizing stress concentrations. A comparison of adhesive bonded joints in magnesium to riveted and spot welded joints proved the bonded joints to be far superior. Under the same dynamic loading conditions, spot welded assemblies failed at 12 million cycles; riveted, at 18 million cycles; and adhesive bonded, at 240 million cycles.

2. Fabrication costs are frequently reduced. A contributing factor is the use of unskilled labor for many of the operations.



Fig. 5—The rear head is welded to the shell of a magnesium semi-trailer tank by the inert gas arc method

3. With the newer adhesives, which require only slight bonding pressures, tooling can be relatively simple and inexpensive.

4. Faying surfaces are filled and protected from corrosion by the adhesive. This is particularly helpful where galvanically dissimilar metals are joined.

The aircraft industry is rapidly expanding its use of metal bonded magnesium structures. The magnesium waffle grid, previously mentioned as a formed sheet application, is metal bonded to B-36 bomber contour skins to increase surface rigidity.

II. Automotive Applications

1. Magnesium Vehicle Wheels

The serviceability of magnesium automotive-type wheels has been quite well demonstrated by their popularity on racing cars, their widespread use on midget racers, service tests on passenger automobiles and the military jeep, and the development of a commercial truck and trailer wheel that has been adapted to an Army radar trailer.

A 9-lb cast magnesium automobile wheel has been demonstrated to provide satisfactory serviceability when substituted for a 20-lb fabricated steel wheel. See Fig. 6.

Various automobile men have attributed several advantages to the magnesium wheel. We have been told that the reduction in unsprung weight improves the riding characteristics of the vehicle and

increases tire mileage. Increased resistance to denting and other mechanical damage has been demonstrated.

The machined cast magnesium wheel has been reported to run truer than a fabricated steel wheel with a reduced tendency toward shimmy and tramp.

Although means have not yet been found for producing a magnesium passenger automobile wheel at a favorable cost, the economic considerations are now favorable to the magnesium commercial vehicle wheel.

The commercial highway transportation industry is currently paying a substantial premium for weight saving. There is every indication that the amount of this premium will continue to increase. Today an average cargo being transported 350 miles represents a revenue of 80¢ per 100 lb. Three round

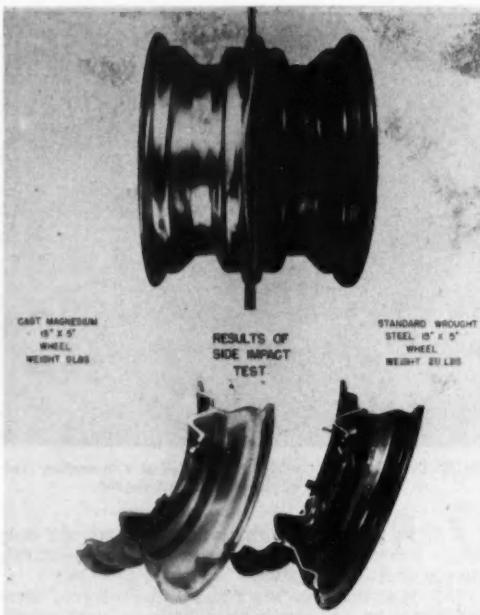


Fig. 6—Note in the above view that a cast magnesium wheel withstands impact testing better than a standard wrought steel passenger car wheel. The structural designs are compared in the lower photos

trips per week, carrying the extra 450 lb of cargo weight made legal by the substitution of magnesium for steel wheels, would in just that one week bring in an extra \$21.60 of revenue to the operator without any additional operating expense. In a year's time this would amount to more than \$1,000 of extra profit.

It has been mentioned that magnesium automobile wheels, weighing around 9 lb, have proven adequate substitutes for steel wheels weighing 20 lb. The same approximate ratio of weight saving can be realized in the larger commercial wheels.

For instance the weight statistics in Table I may be referred to for appraising the competitive situation.

The magnesium wheel assembly is approximately 200 lb lighter than the lightest aluminum assembly, and 460 lb lighter than the lightest steel assembly.

In the development of practical and serviceable designs for magnesium automobile wheels, leave was taken of the rigid, ribbed strut wheel that in magnesium has become standard equipment on the majority of our aircraft. Instead, the flexible disc design of steel automobile and Budd-type truck wheels was adapted to magnesium.

Automobile wheels for testing have been produced by sand casting over size and subsequently machining to finished size and shape. In production, such wheels would be cast directly to size by permanent mold or die casting methods. Another possibility is press forging.

Experimental work on both the automobile wheel and the truck wheel has proceeded far enough to

establish the practicability of several tentative designs. The remaining job involves further refinement of these designs and their adaption to production tooling.

2. Wheel Hubs, Brake Shoes and Spiders

There are opportunities for using magnesium to reduce the weight of running gear components other than that presented by the wheels. Several firms working independently have developed magnesium hubs for Budd-type wheels that have worked out exceedingly well. These hubs are applicable to wheels made of magnesium, aluminum, or steel.

The four magnesium hubs required for a tandem axle weigh approximately 110 lb less than the malleable iron hubs they replace.

One Midwestern firm markets an axle that uses magnesium brake shoes and brake spiders, as well as wheel hubs where disc wheels are to be used. These parts have been remarkably free of the service troubles and need for design revisions that usually accompany any new development.

Production of these parts began as sand castings with conversion to permanent mold now under way. See Fig. 7.

The axle with magnesium parts is approximately 150 lb lighter than their standard steel axle. The approximately 300 lb of weight that can be saved on a tandem axle has been extremely welcome to many operators of over-the-highway equipment.

3. Truck Bodies & Semitrailers

The economics which justify a premium being assigned to lightweight equipment used for over-the-road hauling focused attention nearly two decades ago on magnesium sheet and extrusions for truck and trailer body construction.

Construction of many bodies in the early '30's served to detect the principal technical problems to be overcome. One of the principal problems involved proper paint finishing systems.

Magnesium, like steel, depends principally on organic finishes for protection against the elements. Paint primers developed for steel did not work well on magnesium. This proved to be a troublesome problem for many years.

Zinc chromate primers, developed during World War II for aircraft applications of magnesium and aluminum, depended primarily for adhesion on the prior application of a chemical surface treatment that did not prove practical for many commercial applications of magnesium. It has only been within the last three or four years that simple and reliable paint systems have been available for finishing magnesium.

Another problem, and a serious one, springs from the galvanic reaction when magnesium is coupled to a more noble metal, such as steel, in the presence of a suitable electrolyte.

As a result of the attention focused on this problem, caulking compounds, insulating tapes, and shim materials are now widely available for minimizing the galvanic corrosion problem where it is necessary to join magnesium to steel.

Rivets made of aluminum alloys bimetallically compatible with magnesium are now commonplace.

Zinc or cadmium plating of bolts, nuts, and body hardware provided solutions to other problems.

The custom truck body building industry was the first to capitalize on magnesium's ability to provide a lighter weight, yet equally serviceable body. Complete frameworks are fabricated from magnesium extrusions, which, in a single section, provide a part such as a roof cap that in steel often requires three or four separate parts joined together.

Covering sheet may be either magnesium or a compatible aluminum alloy. The magnesium sheet is, of course, the lightest and enjoys considerable demand. But until new rolling mill facilities and increased production result in lower production costs for magnesium sheet, there will be certain markets more effectively reached by a composite body utilizing magnesium extrusions and aluminum sheet.

A composite magnesium and aluminum body has proven more attractive to the van semitrailer builder than all-magnesium construction because of the relative cost of magnesium sheet.

The modern "frameless" van semitrailer is much more complex structurally than simple van panel truck bodies. That's why introduction of magnesium into trailer construction has proceeded more conservatively.

Good results are being obtained with magnesium structural members in trailer construction, and this use for magnesium is expected to increase rapidly.

4. Trailer Flooring

As magnesium moves into new uses where it replaces an already established material, the change-over sometimes involves nothing more than a simple change in material. The design, production method, and tooling remain the same.

Quite often, however, it proves more efficient to completely redesign for magnesium. This often involves a new form of material, as for instance, a magnesium die casting or extrusion for a fabricated steel part. The application of magnesium to van trailer flooring is an example of progressive, new thinking that involved a new fabricating method as well as a new material.

Considerable progress had been made in recent years toward reducing the weight of trailer framework, covering skin, running gear, and landing gear. But no one had come up with a practical flooring material that was significantly lighter than the old wood floor. Then Fruehauf Trailer Co. began thinking about extruding magnesium into an integrally stiffened floor plank for their trailer.

Consultations between designer and extruder evolved a practical design that was offered as optional equipment in the fall of 1948. See Fig. 8.

Market acceptance and service experience with this new type of flooring material were sufficiently favorable that new model trailers subsequently announced included the extruded magnesium flooring as standard equipment.

Weight saving made possible by this new flooring material is extremely popular with the truckers. When one considers that there are approximately 250 sq ft of floor in a 35-ft van, it is easy to under-

stand the enthusiasm aroused by this new flooring material. It saves 900 lb per trailer over the old-style floor of 1-3/4-in. oak.

Tests currently being run by Lockheed in the cargo version of the Constellation point to its inclusion in that plane. Other plane manufacturers are running tests and plan extensive use of this type of flooring material.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Table 1—Comparing the Weight of Steel, Aluminum, and Magnesium Vehicle Wheels

Tandem Axle—Dual Wheels—10:00×20 Tire Size			
	Cast Steel Spider Type	Forged Aluminum Spider Type	Cast Aluminum Spider Type
4 Spiders	352 lb (Steel)	160 lb (Al)	132 lb (Al)
8 Steel Rims	596	596	596
Total (Integral Hub)	948 lb	756 lb	728 lb
	Steel Disc Type	Aluminum Disc Type	Magnesium Disc Type
8 Discs (Integral with Rim)	864 lb	556 lb	400 lb
4 Hubs	224	132	88
Total	1088 lb	688 lb	488 lb

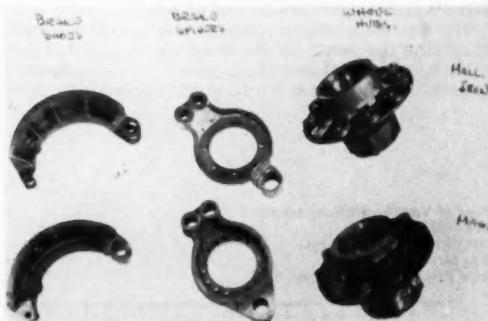


Fig. 7—Compared here are the design of brake shoes, spider, and wheel hubs in sand cast magnesium (lower row) and in malleable iron (upper row).

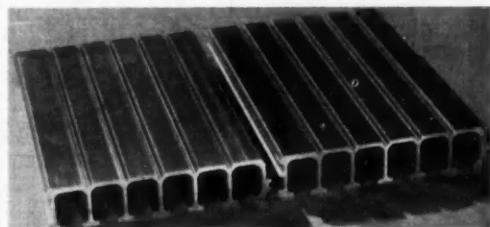


Fig. 8—This type of extruded magnesium trailer flooring can save several hundred pounds of weight per trailer.

Highway Tractors

HIghway tractors need more power. The performance gap between these and other road vehicles is far too great. This gap must be cut or the increasing number of highway tractors on the road can easily become a nuisance to the motoring public.

Today a well-powered, fully loaded automobile carries 35 to 50 lb per net hp; an intercity bus, approximately 150 lb; a highway truck, about 250 lb . . . and a highway tractor, 350 to 550 lb per net hp. But these vehicles all operate on the same highway, in the same traffic, and over the same grades. Thus the extremes in performance that result from these different weight/power ratios can't be justified.

Neither can the effort that goes into driving a highway tractor. Present-day practice of substituting gears for power has weighed heavily on truck drivers. Forced to make many manual gear shifts to get trains underway—and keep them going—drivers grow "old" fast.

The highway tractor powerplant and the means of getting the power to the wheels have not changed enough in the last few years to indicate satisfactory progress. Some new, more powerful engines have

appeared, but, generally speaking, they have been used to pull greater loads rather than improve standards of performance.

Too Many Engines Available

As a matter of fact, right now there are too many engines available to the motor truck industry. The engine builder's practice of having a long line of engines, varying in small increments of displacement with—in many cases—overlapping power output, has confused matters.

One prominent manufacturer of heavy-duty truck engines, for example, offers a line of 16 gasoline engines varying in displacement from 237 to 935 cu in. and in horsepower from 91 to 227 hp. This is a horsepower variation of only 250% for a displacement variation of nearly 400%. Furthermore, some of these engines overlap in horsepower output. For instance, two engines of 404 and 501 cu in. displacement put out 139 and 137 hp, respectively.

Other manufacturers, too, have overlapping engines. One has engines of 893 and 977 cu in. displacement which are rated at 199 and 200 hp. Another has two engines with 404 and 517 cu in. dis-

Type of Vehicle—Highway tractor
Gcw—50,000
Net Horsepower—120 (gas)
Tire Size—11.00 × 22
Axle Ratio—High, 6.45; Low, 8.86

Transmission Ratios—First, 6.17
Second, 3.40
Third, 1.79
Fourth, 1.00
Fifth, 0.855

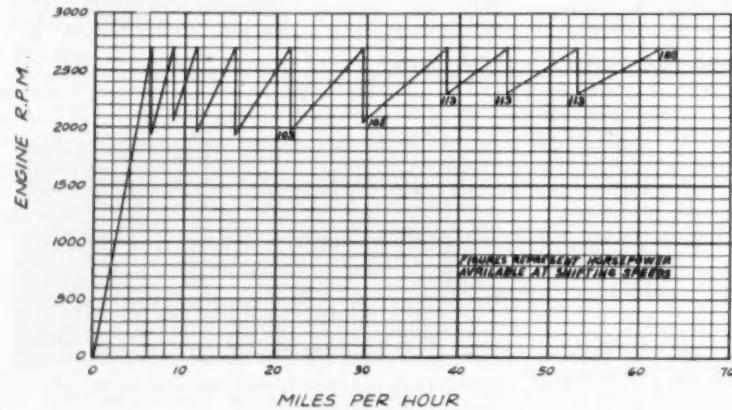


Fig. 1—Low available horsepower necessitates making transmission shifts close together. This keeps loss in engine rpm to a minimum and assures maximum available horsepower at the point of shifting

Need More Power!

BASED ON PAPER BY

N. R. Brownyer, Timken-Detroit Axle Co.

Paper, "Effect of Weight/Power Ratio on Highway Transportation," was presented at SAE National Transportation Meeting, Chicago, Oct. 31, 1951. (This paper will be printed in full in SAE Quarterly Transactions.)

placement that develop 128 and 126 hp in that order. A good example of duplication are two engines in the same line with identical displacement (320 cu in.), one a L-head, the other a valve-in-head, that put out 104 and 122 hp, respectively, at the same rpm.

These long lines of overlapping engines have made engineers vacillate in their opinions about the correct engine for a given vehicle.

Horsepower Best Yardstick

Some years ago, it seemed reasonable to choose engines on the basis of displacement rather than horsepower. (A popular yardstick was 100 lb per cu in.) Actually, however, nothing but horsepower will get a train over a hill at a given speed.

Then why are tractor manufacturers so concerned about overpowering their vehicles? They're worried that continual upping of horsepower will in-

crease engine weight, the weight of mechanical units back of the engine, and boost fuel costs. But this hasn't proved the case with passenger cars, and there's no reason why it should with tractors.

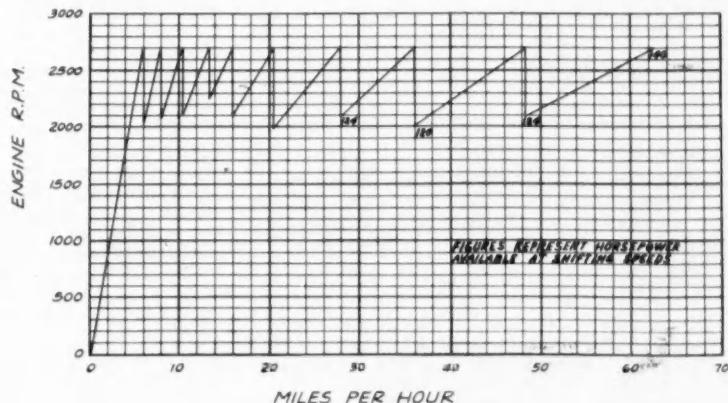
The factors necessary to get high output, low weight, and extreme compactness have been known and used by engine men for many years. Some of these factors are:

1. Multicylinders.
2. V-type engines.
3. Valve in head.
4. High compression.
5. Lightweight piston and rod assembly.
6. High rpm.

The present Cadillac engine started a trend that has resulted in practically an avalanche toward valve-in-head, high-compression V-8 engines for passenger cars. And some of these high output en-

Type of Vehicle—Highway tractor
Gcw—50,000
Net Horsepower—140 (gas)
Tire Size—11.00 x 22
Axle Ratio—High, 5.54; Low, 7.09

Transmission Ratios—First, 7.81
Second, 4.67
Third, 3.06
Fourth, 1.72
Fifth, 1.00



Type of Vehicle—Highway tractor
Gcw—50,000
Net Horsepower—180 (gas)
Tire Size—11.00 × 22
Axle Ratio—High, 6.05; Low, 8.95

Transmission Ratios—First, 6.07
Second, 3.41
Third, 1.79
Fourth, 1.34
Fifth, 1.00

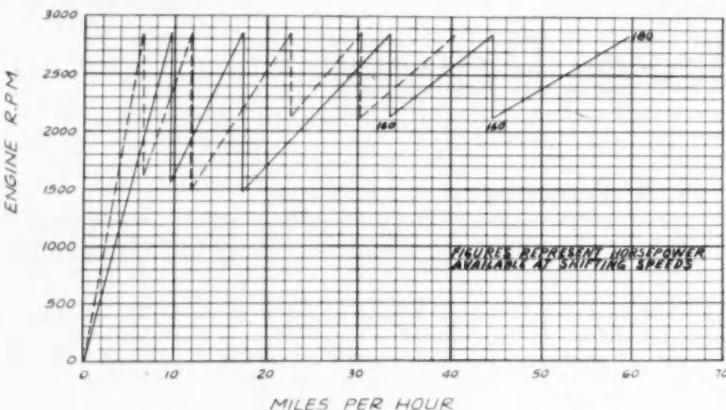


Fig. 3—In congested areas, this train would be operated as a five-speed proposition in the low range of the axle. When used on the open highway, it would be operated in the high axle range. On the assumption that the 180 hp is obtained at an economical weight, this combination is the best available from the standpoint of simplified operation, light weight, and low cost

engines are going to find their way into trucks. Undoubtedly, this will create a demand for this type of powerplant in larger sizes because it points out the means for getting high output without size and weight penalty.

Already a new truck engine has appeared on the market that incorporates many of the design features of these high output passenger-car engines, including an extremely high bore/stroke ratio. This 540 cu in., valve-in-head V-8 gasoline engine develops maximum horsepower at 3000 rpm. It may well be the forerunner of a new era in lightweight truck engines that will result in a line of highway tractors, powered as indicated in Table 1.

There's a feeling in some quarters that the basic high-speed passenger-car engine won't stand up in truck service. This is the result of the practice of hauling as much as an engine will pull, leaving no cushion for hill climbing, passing other vehicles, or emergencies. But an airplane engine with a variable-pitch propeller wouldn't last long at take-off horsepower. Likewise, if the 150 hp V-8 engine designed to pull 35,000 lb were called upon to pull 60,000 lb, the life of both engine and transmission

would be shortened. The very fact that most present-day truck engines operate at maximum speed and output almost all of the time is the reason they are heavy. It's also the reason why it is feared that any increase in horsepower will add materially to weight.

In most cases, if the same displacement were worked into a multi-cylinder, higher speed engine, some reserve horsepower would be available and it wouldn't be necessary to work at maximum output—if we were content to improve performance instead of cashing the additional power by pulling a heavier train. Some day new high-speed gasoline engines and new supercharged diesels made of lightweight material will solve this phase of the problem.

To complete the picture, however, driver fatigue must be reduced by simplifying the operation of the vehicle.

Driver Needs Crystal Ball

As a substitute for adequate power the driver has been given more gears to shift. This, in itself, is not too bad. But, when a driver is called upon to split gears by alternately shifting the transmission and the auxiliary transmission or two-speed axle, he needs a crystal ball to determine which is proper at a specific time.

It's feasible to believe that a driver should be able to learn how to cope with this problem if every truck had these transmission components. But there's no pattern that's acceptable to all truck engineers . . . and for good reason. Enough difference exists in the available power in each train to make a standard specification impractical.

Thus, until highway tractors are adequately powered, two-speed axles, auxiliary transmissions, or ten-speed transmissions will have to be used to compensate for lack of power. Much can be done in the interim period, however, to make shifting easier and to get the most out of an engine.

It's just a matter of tailoring the gear shift pat-

Table 1—Weight-Power Trend for Highway Tractors

Gross Train Weight	Net Horsepower	Gross Horsepower
30,000	130	145
40,000	150	170
50,000	180	205
60,000	200	230
70,000	225	265
80,000	250	300

These figures represent a gradeability of 1/4% at 60 mph.

tern to suit the conditions of gross train weight and available power. Let's look at a few examples of both good and bad systems . . . and see how the bad ones can be improved.

Each of the systems to be considered was geared for a top speed of 60 mph, since—if adequate power were available—this would insure:

1. Working below maximum engine output a good part of the time—assuring longer engine life.
2. Some reserve for (a) emergency in passing, (b) hill climbing, and (c) reducing the amount of gear shifting.

Fig. 1 shows the shifting chart for a 120 net horsepower gasoline engine used to pull a 50,000 lb gross train. The low available horsepower necessitates making transmission shifts close together. This keeps loss in engine rpm to a minimum and assures maximum available horsepower at the point of shifting.

This system consists of a five-speed over drive transmission with a short step at the top in combination with a two-speed axle with a 1.37 step. It represents a maximum of shifting and is a far cry from our ambition to have a simplified control. (It is, however, one of the most satisfactory arrangements available to help a small engine do a big job.)

Fig. 2 shows the application of a bigger engine—140 net horsepower—to this train. This additional power justifies spacing transmission shifts further apart, in keeping with the urge to simplify the work of driving a motor truck.

In this case, the combination consists of a five-speed transmission with steps that are quite evenly split by a two-speed axle having a 1.28 spread from high to low. This system requires alternate shifting of the transmission and the axle, but it's a distinct forward step over the vehicle with the smaller engine and very frequent speed change.

Fig. 3 shows the shifting chart of this 50,000 gross train when equipped with a 180 net horsepower engine. This unit has a five-speed transmission with a narrow step at the top in combination with a two-speed axle having a 1.48 spread. In congested areas, the train would be operated as a five-speed proposition in the low range of the axle with a top vehicle speed of about 41 mph. When used on the open highway, the train would be operated in the high axle range.

On the assumption that the 180 hp is obtained at an economical weight, this combination is the best available from the standpoint of simplified operation, light weight, and low cost.

More Power Still Key

These examples illustrate graphically what happens when a tractor is underpowered—the driver is penalized by having to make more frequent shifts. It's true that shifting of underpowered trains can be simplified by gearing them for top speeds more consistent with their ability. But this isn't the answer to the present-day "nuisance" and driver fatigue problems. More power, that's what's needed!

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Excerpts from discussion

F. B. Lautzenhiser

International Harvester Co.

THE solution to the problem of traffic congestion on hills is not to be found in the mere installation of larger and more powerful engines in trucks.

Even if powerplant output could be doubled, the present 2 to 4 mph now attained on steep slopes might only be stepped up to 6 or 8 mph. Such a trivial improvement is not likely to be considered an improvement by impatient motorists.

What's more, this so-called "improvement" would increase the hazard of passing by lengthening the distance required to pass, thus aggravating the condition it was designed to ameliorate.

The only sound and sensible solution to this problem is to provide auxiliary, bypassing lanes for trucks on steep grades.

As for future weight/power ratios, Brownyer anticipates 130 hp for a 30,000 lb gross train; 200 hp for 60,000 lb; and 250 hp for 80,000 lb gross. These are weight/power ratios of 230 to 1, 300 to 1, and 320 to 1.

In my opinion, these vehicles would be badly overpowered from the standpoint of the economics involved.

R. C. Wallace

Diamond T Motor Car Co.

MR. BROWNYER states that satisfactory progress has not been made in truck powerplants. However, it seems to me that horsepower output of all engines has been going up rapidly in the last few years. It is true that engines originally designed for a specific load are now being used for greater loads. But, even with these greater loads, they are living longer, giving better economy, and better running speeds. These factors certainly indicate that improvements have been made.

It also might be pointed out that the power/weight ratio of certain cars is now in the order of 60 hp per ton. If we were to maintain this ratio—or even approach it—in trucks, engine size would be prohibitive.

Great possibilities do exist for improvements in transmissions, auxiliary transmissions, and axles, but, here again, great progress is being made.

In my opinion, there is no one solution for all geographical locations. Adequately close splits, it is true, will greatly benefit the adequate as well as the inadequate engine. But the difference in types of transmission and axle combination are more determined by geographical location than is generally recognized.

However, regardless of geographical location, gear ratios should be selected so that the ratio between the two lowest numerical reductions is in the neighborhood of 1.25 or less. This will give best operation under all climatic conditions.

It is my understanding that builders of larger en-

gines are much more particular about keeping them within a limited range of rpm than builders of smaller engines. Therefore, it is just as important to have the close steps on large engines to get longer life as it is to have close steps on small engines to utilize the higher speed horsepower.

L. C. Kibbee

American Trucking Associations, Inc.

THE author states that the driver situation may deteriorate to a dangerous degree. In my opinion, he has overstressed the difficulty in training a driver. With the mention of 10 or more speeds forward, it is immediately assumed that it takes a magician to operate the transmission.

Truck lines which operate such expensive equipment train drivers to shift these transmissions com-

petently. In short, truck drivers know what they're doing.

Adding power to a motor truck is a pure case of economics. For example, let's look at an East Coast operation—Baltimore-Newark.

With the opening of the New Jersey turnpike, the time between these two points has been cut 2 hr, but at the penalty of a \$7 toll. Thus, it costs \$7 more to render service for the same rate.

Drivers don't get paid by the hour, but rather from portal to portal. Therefore, nothing is saved in driver wages. To add insult to injury, if the driver can't be turned around within 8 to 10 hr, he has to be paid at the rate of \$1.25 per hr for waiting time. Perhaps the speedup might result in getting the shipment to Newark at 2 a.m. instead of 4 a.m. Then, unless you want to pay dock men double time to unload on the "graveyard shift," the freight just sits. Probably the customer doesn't open for business until 8 a.m., anyway.

Does this operator need more power in his tractors?

Bulldozer Performance . . .

. . . hinges on internal friction and cohesion of soil since these properties affect flotation, traction, and blade performance.

BASED ON PAPER BY J. W. Martin and D. B. Folger Cyrus-Erie Co.

THE influence of soil on bulldozer performance and the lack of adequate data on its properties raise the question how best to approach bulldozer design. One approach is to study units which are being used successfully in the field, and with this in mind, data on industrial track laying diesel units with standard hydraulic dozer attachments were obtained from four leading manufacturers.

It is common to think of a safe ground load as its bearing capacity and refer to it in terms of load per unit of area. When unit weight was plotted against track area for the dozers being studied, it was found that average bearing loads ranged from 7.6 psi to 8.9 psi and 5.9 psi to 7.7 psi, respectively, for the normal and maximum track shoes as the weight increased from 10,000 to 40,000 lb. Individual manufacturers' units fell within narrower limits, but were still bands rather than simple straight lines. The largest and newest products of three producers were out of line, showing higher unit pressures.

Soil resistance under vertical pressures is not uniform. It is greater at the center because of the restraining effect of soil friction. Total supporting capacity does not, therefore, increase in proportion to the area. A better relationship for flotation can be reached by using a civil engineering formula for determining safe wall weight which employs the shape of area as well as the factor of area. Plotting this factor against both unit and bare machine weights reveals that dozers in service do not follow a well defined trend which is indicative of typical field requirements.

When total machine weight is plotted against the

theoretical tractive force, it establishes the relationship of weight to maximum force which the engine can develop. Such a plot shows there to be no consistent trend. The average theoretical force for these machines cannot be expected to exceed 80% of unit weight, and the ratio of available force to weight varies through an appreciable range.

Track area and grouser area should be proportional to the force which can be transmitted to the soil, reasoning that the greater the areas the greater the contact with the ground. If these relationships are plotted for the dozers in question, it reveals that manufacturers followed a straight line relationship with respect to track areas for the smaller machines, while the largest for three producers was completely out of line, tending toward a higher ratio of tractive power to area in two cases and a lower ratio in the third. This discrepancy indicates either new physical limitations or a modified concept of traction requirements. The grouser area to tractive power curves for each manufacturer were not out of line.

When tractor and blade proportions were studied it was found that neither blade length nor area can be used as a guide in proportioning blade size to tractive power. The best correlating factor, independent of soil characteristics, proved to be the blade length to the third power. (Paper, "Bulldozer Power and Dimensions," was presented at SAE National Tractor Meeting, Milwaukee, Sept. 11, 1951. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

Manual Details

How to Salvage Castings

IRON and steel castings marred by defects can be salvaged in many cases. SAE's newly published manual "Repair of Ferrous Castings" tells step-by-step how to do it.

Experience during World War II and since has shown that it's often more economical to repair a casting than to scrap it—and just as satisfactory to the user. The SAE manual outlines proved repair practices for the benefit of all founders, especially small shops that may someday be drawn into production of unfamiliar defense items in time of national emergency. Gray iron, malleable iron, and steel are covered.

First thing for the foundryman to do with an imperfect casting, the manual says, is to determine the extent of the defect. Porous areas will show up in pressure tests. Small cracks and other minor defects should be opened up by drilling, chipping, grinding, or filing. Larger defects it's better to examine by some nondestructive means such as x-ray, gamma ray, magnetic particle, or fluorescent oil inspection.

Porous areas where water under test pressure seeps through at a rate not over 2 drops per sec may be repaired by adding a little sal-ammoniac to the pressure-test water and subjecting it to pressure of 65-100 psi, according to the manual. Or, in gray iron or malleable iron, such areas may be peened with a round-nosed hammer. Coarser po-

Reviewed here is "Repair of Ferrous Castings," a manual just issued by SAE at 75¢ to members and \$1.50 to nonmembers.

ISTC Divisions IX and X are responsible for the manual. Since it was approved for publication, Division IX has received further data on welding of cylinder-bore defects. This information will be presented in next month's SAE Journal.

rosity where the water sprays through in a fine mist but not in a solid stream, can be sealed with a polymerizing resin or a high-silica, low-alkali silicate. The sealer should be poured into the casting cavity and forced into the leaks under at least 50 psi pressure. Then the casting should be drained and baked.

For leaky areas subject to compressive or low tensile stresses, the manual suggests bushings or threaded plugs of material similar to the casting. Both bushing or plug and the mating part of the casting should be coated with a litharge-glycerine mixture or other suitable sealer before the repair piece is positioned.

Defects such as underfills or cracks can sometimes be remedied by welding, brazing, or soldering. The manual gives detailed instructions on how to carry out these repairs on gray iron, malleable iron, and steel. As a sample, the instructions for nickel welding of gray iron crankcases are reproduced in Fig. 1. Similar sections cover arc and gas welding and general nickel welding as well as brazing, silver brazing, and soldering.

The 18-page manual is an up-to-date revision of the castings-salvage part of the SAE "Foundry Process Control Procedures," which has become obsolete and is out of print. Division IX—Automotive Iron Castings and Division X—Automotive Steel Castings are responsible for the revision. They are Divisions of the SAE Iron and Steel Technical Committee. V. A. Crosby of Climax Molybdenum is chairman of Division IX, and Gosta Vennerholm of Ford is chairman of Division X.

The new "Repair of Ferrous Castings (Gray Iron, Malleable Iron, and Steel)" is SAE Special Publication SP-22. It is available from the SAE Special Publications Department, 29 West 39th Street, New York, at 75¢ to members and \$1.50 to nonmembers.

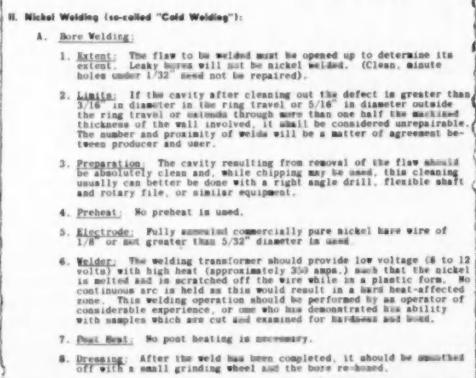


Fig. 1—Reproduction of section on nickel welding to repair defects in cast gray iron crankcases

Instrumentation for

MORE and more instrumentation is being used in the laboratories where aircraft gas turbine powerplants and their components undergo development testing.

Power measurements now require huge 24,000-hp dynamometers, and delicate speed-measuring devices of better than 1% accuracy. . . . Vibration studies depend on the recording of strain gage signals of frequencies as high as 30,000 cps. . . . Determinations of rotor strength at operating temperatures rely on transference of thermocouple voltages from machinery rotating up to 15,000 rpm to potentiometer-type temperature indicators. Temperature and pressure probes for internal aerodynamic data must be positioned by remote control. . . . Burner development studies involve gas

analyzers, radiation-measuring equipment, and high-speed cameras.

All these types of instrumentation and still others were discussed January 17 at a session of the SAE Annual Meeting in Detroit. Two Pratt and Whitney Aircraft men—R. E. Gorton, development engineer, and B. E. Miller, assistant project engineer, of the P&WA instrumentation group—presented a paper "Instrumentation for Aircraft Gas Turbine Development." The paper is available in full in multilithographed form from SAE Special Publications Department. Price is 25¢ to members, 50¢ to nonmembers.

Examples of instrumentation described in the paper and by two of its discussers follow.

Pratt & Whitney Aircraft Instrumentation

BASED ON PAPER BY R. E. GORTON and B. E. MILLER, Pratt & Whitney Aircraft Division, UAC

Electronic Counter Tachometer

This device does basically the same thing as an electric clock-revolution counter instrument. A slotted disc driven by the engine produces many impulses per revolution by photoelectric or electromagnetic action. This permits the electronic counter to count fractions of revolutions. An adapter containing the slotted disc and an electromagnetic pickup fits between the aircraft tachometer generator and its pad. The time base is generated by a crystal oscillator at radio frequency. A second electronic counter counts a pre-set number of cycles of this oscillator signal to determine the time interval during which engine revolutions are counted. This time interval may be as short as one second. After a few seconds for reading the count, the operation is automatically repeated. By thus speeding up the counter operation, readings may be

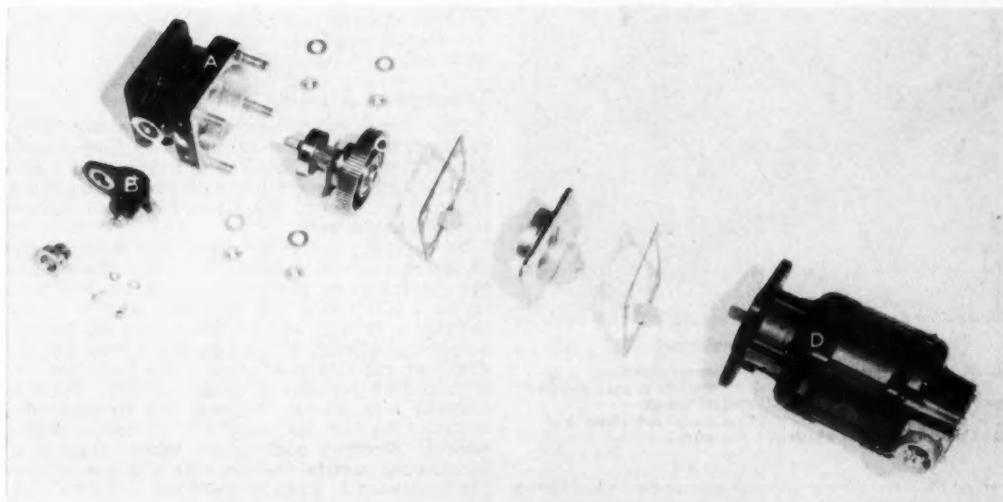
obtained every few seconds, with accuracy of better than 0.05%. This type of instrument has the disadvantages of expense and complication, but will provide speed-measurement ability not otherwise obtainable.

Small Speed Change, Big Thrust Change

It's important to have the accuracy because a small variation in speed can explain a sizeable change in thrust, and military specifications call for thrust measurement accurate to 1%. For one type of engine a 1% change in speed caused a 7% change in thrust. To repeat thrust measurements to 1% accuracy, the speed must be set to one-seventh of 1%—which means that speed-measuring instrumentation is desired accurate to about 0.1%.

The electronic counter tachometer not only ex-

Developing Gas Turbines



Tachometer adapter incorporating an electromagnetic pulse generator

A—Adapter housing

B—Electromagnetic pickup

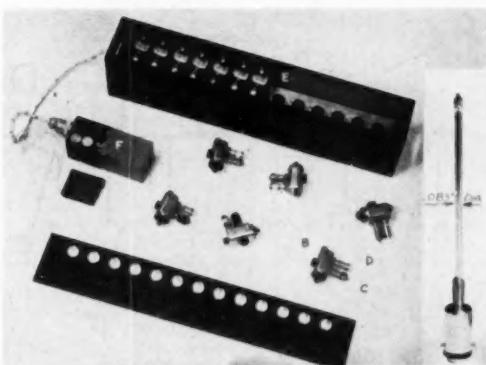
C—Toothed wheel

D—Standard tachometer generator

ceeds this degree of accuracy, but also avoids two disadvantages of the usual speed measuring devices: The revolution counter-electric clock combination gives an average speed over an interval of the order of one minute—a longer time than is acceptable in some cases. The stroboscope or synchroscope arrangements generally permit accurate setting of only certain discrete speeds.

Blade Rubbing Indicator

If due to run-out, warping of the engine cases, or rotor growth with heat or centrifugal force there is a fear that blades may rub, a compressor may be fitted with electrical contacts to trigger a rubbing indicator. The surface against which rubbing is feared is fitted with several insulated electrodes of fine wire, which project a few thousandths of an inch from the surface toward the blades. A blade touching any one of the electrodes makes a contact which is used to flash a warning light. Since the actual time of contact may be extremely short, a means is provided for holding the light on for several seconds. The electrical circuit through the motor bearings may be of quite high resistance



Thirteen-channel rubbing indicator constructed to warn of rubbing in any one of the 13 stages of a compressor

A—Contact of probe (in inserted enlarged view)

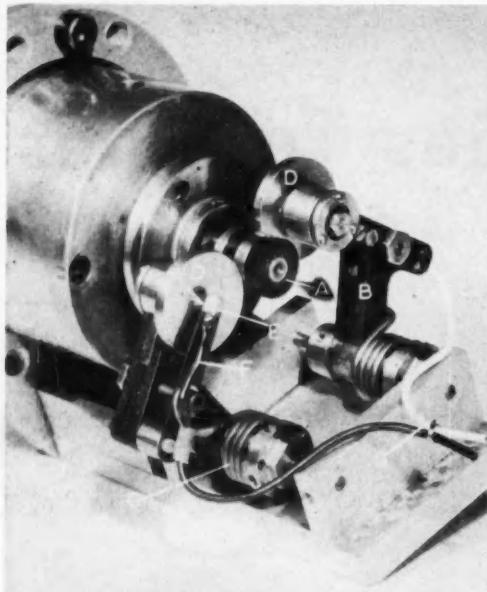
B—Plug-in relay assembly

C—Trigger tube

D—Sensitive relay

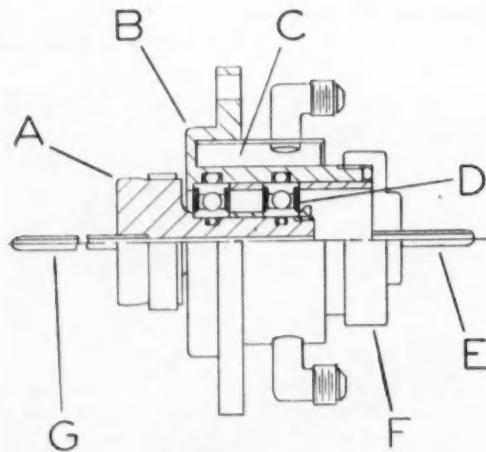
E—Rack for 13 plug-in units

F—Power supply



Temperature transfer unit

A—Shaft with chromel and alumel rings	E—Chromel and alumel cone contacts at wheel centers
B—Plastic follower arm	F—Leaf springs
C—Torsion spring	G—Chromel and alumel lead wires
D—Chromel and alumel wheels	



Pressure transfer unit

A—Shaft	D—Bearing with synthetic rubber seal
B—Housing	E—Pressure tap to manometer
C—Cooling-water jacket	F—Cap
G—Pressure tube to selector shaft	

unless the rotor is especially grounded. The short duration and high resistance of the rubbing signal require a high-speed, sensitive relay circuit, accomplished by using a trigger tube to operate a relay. The resistance of contact at which the tube will fire, and the time delay before it re-sets, extinguishing the warning light, are readily adjustable. In test rigs with excessive oil or water the electrodes may become partially shorted, giving false signals. In such cases the electrode is coated with an insulating varnish to prevent shorting, or the rotor may be grounded by a slip ring and brush, permitting a much less sensitive setting of the trigger tube.

Temperature Transfer Unit

This device takes thermocouple voltages from rotating parts of operating turbine engines or component rigs and transmits them to standard potentiometer-type temperature-indicating instruments. Chromel and alumel ribbons and duplex wire lead to the transfer unit.

In the temperature transfer unit chromel and alumel rings are mounted on an insulated shaft and are connected by chromel and alumel wire to a chromel and alumel pin connector at one end of the shaft. Bearing against these rings are chromel and alumel wheels, having a diameter twice the ring diameter, running in bearings in an insulated arm with loading provided by torsion springs. Cones of chromel and alumel material are spring-loaded against a recess in the center of their corresponding wheels. Chromel and alumel wires attached to these cones provide the connection to the indicating instrument. Thus the unit has complete thermocouple-material continuity. The assembly is enclosed with a cover, and oil mist lubrication is provided for the wheel and shaft bearings and the cone contacts.

Resistance Limits Speed

In operation the limiting speed is determined by the increase in circuit resistance of the roller and cone contact points, which causes loss of sensitivity in the self-balancing potentiometer-type indicating equipment. With a single roller follower per ring, this speed is approximately 5000 rpm. With two roller-follower assemblies per ring approximately it is 15,000 rpm. Since most testing is done between these limits, two roller assemblies per ring is the standard configuration. Two sizes of transfer unit assemblies are used, one capable of handling a single thermocouple at a time and the other, two thermocouples.

Connection of the transfer unit to the turbine shaft is accomplished through a plug-in type of connector shaft developed for strain-gage slip-ring applications. This shaft was modified to include a remotely-actuated selector switch which permits the measurement of 12 thermocouples one at a time in one configuration, or 28 thermocouples two at a time in a second configuration.

The advantage of the temperature transfer unit over slip-ring brush methods, slip-ring compensa-

tion methods, or the induction method is that it permits continuous operation without the complication of controlled reference junctions.

Pressure Transfer Unit

For the determination of pressure distribution on blades of low-temperature research turbines a pressure transfer device is used based on a design suggested by the Langley Aeronautical Laboratory of the NACA.

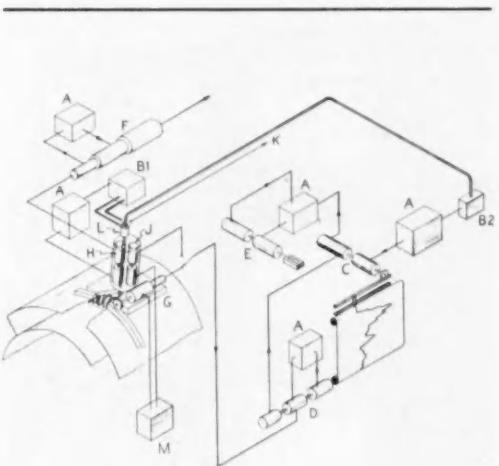
Commercial ball bearings are used having synthetic rubber seals on each bearing face. These seals, reversed from their normal position, are pressed into grooves in the outer race and bear against a formed surface on the inner race of the bearing. A water-cooled housing is provided to contain the bearings. A shaft, having a hole drilled from end to end, is installed in the bearings. Sealing between the bearing outer race and housing and the inner race and shaft is accomplished with O-rings. A cap fitted to one end of the housing locks the outer races of the bearings and contains the stationary pressure tap. Connection of the transfer unit to the turbine shaft is through a remotely actuated pressure-selector shaft having drilled passages arranged to permit selection of 24 pressures, one at a time.

A device of this type has been operated continuously for a period of 40 hr on the test bench at speeds between 10,000 and 15,000 rpm with a pressure differential of 20 to 25 in. of Hg across the bearing. Quality of seal, while not perfect, was sufficiently good to permit measurement with insignificant error of pressures supplied through the restriction of the drilled holes in the turbine blades. The ultimate life of the seal is unknown at these operating conditions, but no change in the rate of leakage was observed during the 40-hr test. This type of seal construction is readily adapted to multichannel operation by stacking the bearings and introducing and taking off the pressures in the spaces between bearings with speed in pressure distribution on a turbine blade, determined with this equipment.

Automatic Plotting and Indicating Equipment

Means of speeding up data recording have been applied to temperature and pressure probe traversing on stationary cascade and rotating compressor and turbine rigs for loss measurements. This system eliminates the tedious point-by-point traversing method and reduces the data-reduction time by producing directly on the test stand a visual plot and on counters the integrated values of the measured variables.

A probe-positioning device is mounted on a motorized platform which can be moved circumferentially around the cascade. Installed in the probe-positioner is a combination probe which gives simultaneous indication of the three variables yaw angle, total temperature, and total pressure. Three strip-chart plotters are provided, one for each variable. The chart-drive mechanism is tied in with the tra-



Automatic plotting and integrating equipment scheme applied to an annular cascade. Equipment was developed cooperatively by Pratt & Whitney Aircraft and the United Aircraft Corp. Research Department

A Amplifiers

B1 Pressure transducer. Output voltage proportional to differential pressure from probe yaw holes

B2 Pressure transducer. Voltage output proportional to probe total pressure

C Pen motor and potentiometer. Pen deflection and potentiometer position are proportional to voltage output from total pressure transducer B2, thermocouple K or probe rotation follower potentiometer F

D Strip chart drive motor, selsyn, and generator. Paper speed and generator output synchronized with traverse speed through servo loop with selsyns

E Integrator motor, counter, and feedback generator. Motor speed proportional to voltage product of generator output D and potentiometer position C

F Probe rotation follower motor, selsyn, and potentiometer. Potentiometer synchronized with probe rotation position through servo loop with selsyns

G Circumferential traverse motor and selsyn. Motor operated from traverse control unit M

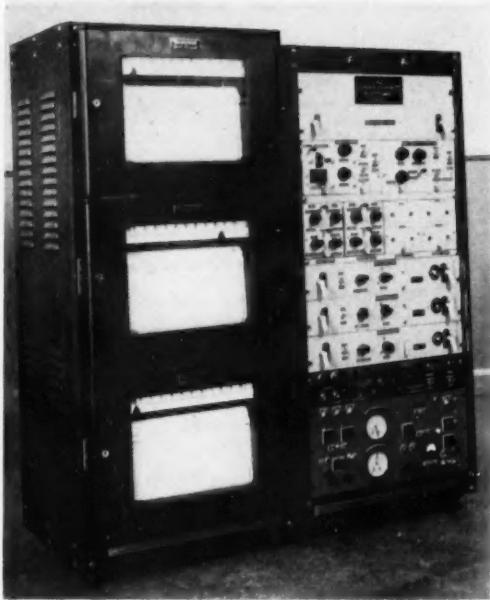
H Probe rotation motor and selsyn. Motor controlled by voltage output from transducer B1 to rotate probe to null balance

I Radial traverse motor and selsyn. Motor operated from traverse control unit M

K Thermocouple

L Probe. Combination type for simultaneous determination of yaw angle, total pressure, and total temperature.

M Manual traverse control unit



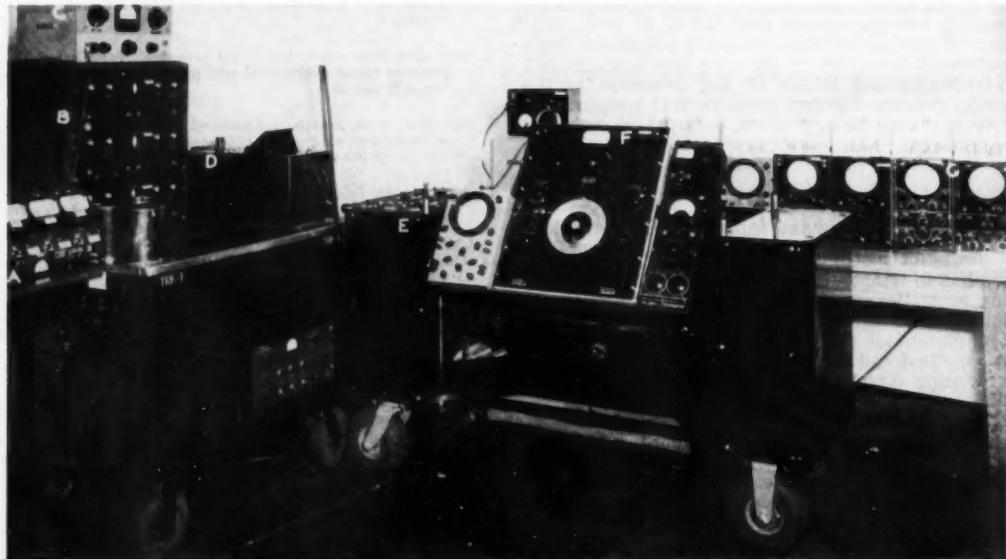
Photograph of the Plottomac automatic plotter and integrator

verse motion by a servo loop with selsyns. Self-balancing yaw equipment indicates angular position by the pen-motion of the yaw-angle plotter. Voltages from the thermocouple in the probe and from the pressure transducer connected to the pressure tap on the probe are supplied to amplifiers which drive the pens on the corresponding plotters.

Connected to the pen-motion of each plotter is a potentiometer excited by a voltage proportional to traverse speed from a generator driven by the strip-chart drive motor. A portion of this voltage proportional to the magnitude of the variable in question is taken off the potentiometer and supplied to the amplifier of a feed-back generator type of integrator. The motor driving the feed-back generator is connected to a counter which indicates the integrated value of the variable over the traversed distance.

Assemblage of Portable Instrumentation

This array of portable special-purpose instrumentation was used during the initial running of one new gas turbine engine type. At the far left at "A" is a four-channel vibration meter. Truck 1 carries amplifiers at "B" for the oscilloscope, on top of the amplifiers at "C" a frequency meter to indicate rotor speed, and a 12-channel oscilloscope for recording compressor blade vibratory strain. The other truck has a strain gage bridge and switch panel at "E" and a wave analyzer at "F." On the table at "G" are six cathode-ray oscilloscopes for visual monitoring of blade vibration.



Some of the special-purpose instrumentation used on one turbojet engine test

Rolls-Royce Instrumentation

BASED ON DISCUSSION BY **DENIS A. DREW**, Rolls-Royce, Ltd., England

Instrumentation Trailer

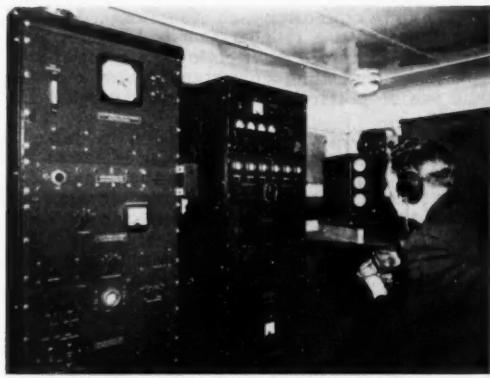
At Rolls-Royce, rack-mounted transportable instrumentation is installed in a trailer of generous proportions. This may be towed to any test bed in any of the Rolls-Royce works or to their air-drome at Hucknall.

The apparatus is kept permanently connected and calibrated. No attempt is made to reduce the size and weight below that which is consistent with stability and ease of operation.

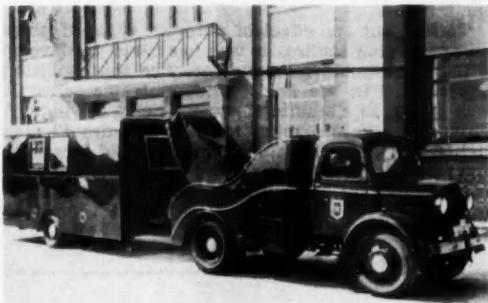
Experience has shown that the added reliability

and accuracy of the nonportable equipment easily outweighs the inconvenience of separating the engineer making the measurements from the engine on test. He is in continuous communication with the engine driver by the use of larynx microphones and loudspeakers. The system has, in fact, one considerable advantage: Only one man in the recording room can talk to the engine driver!

Of course, one trailer is not sufficient to meet the whole of the Rolls-Royce requirements. Other set-ups are also in daily use. At Derby, there is a centralized electronic testing set-up. Work is in hand to connect by means of low loss cables a proportion of the test beds on which elaborate electronic measurements are required.



Interior of instrumentation trailer



Rolls-Royce instrumentation trailer and truck

Allison Instrumentation

BASED ON DISCUSSION BY **JOHN R. BURNS**, Allison Division, CMC

Dynamic Micrometer

Allison uses a device called a dynamic micrometer to measure tie-bolt stretch and radial deflection and growth of compressor stages.

The device is used in connection with spin tests in an underground spin pit. The compressor is installed in a vertical position in the pit. The chamber is sealed off and evacuated to a very low pressure. Then even a large compressor can be spun at its rated maximum speed with a small air turbine.

The dynamic micrometer consists of a remotely controlled motor-driven micrometer having a soft

metal point at the end of the spindle. A potentiometer is attached to the thimble and forms part of an external bridge circuit, whose adjustable arm is calibrated in terms of spindle movement.

In operation, the micrometer is set up in proximity to the section of the compressor and adjusted so that the tip just contacts it. This condition is indicated on an electron ray tube. The micrometer is then backed off. After the compressor has been brought up to the desired speed, the micrometer is advanced by intermittent operation of the remotely controlled motor until the compressor is again contacted.

The difference in readings shows the growth.

4 Ways to Combat Auto

1. Change Spark Plug Design . . .

H. N. Metzel, Oldsmobile Division, GMC

CHANGING spark plug design . . . that's the approach that has given Oldsmobile's Experimental Engineering Department the most promising results.

To find out the effect of different types of plugs on spark plug fouling, it was necessary to develop a test that would reliably reproduce the condition experienced in the field. Thus, a traffic schedule was set up to simulate slow-speed city driving. A circular route, 8½ miles long, it includes 23 stop lights, two stop streets, and four railroad crossings. Cars do not exceed 25 mph and make only light accelerations. To determine the point at which missing occurs, the cars are accelerated at wide open

throttle to 50 mph after each 500 miles.

Equipped with a reliable field test, efforts were next directed toward determining the effect of plug heat range on fouling since many dealers reported that use of hotter or colder plugs corrected the trouble.

The plugs tested so far are listed in Table 1. Oldsmobile's present production plug is designated type A-1. Types A-2 and A-3 are the same design except for the material used in the center electrode. Type B-1 is the next hotter heat range plug made by our production source. Types B-2 and B-3 are identical with B-1 except for special high electrical-thermal conductivity electrodes. With this

Three Types of Spark Plug Fouling

SPARK PLUG FOULING in passenger cars is not a new problem. But recent trends toward more powerful engines and greater traffic congestion are making it a far more serious one.

That's because engines operate at part load more of the time. And extended periods of slow-speed driving result in lower spark plug temperatures . . . increasing the rate at which lead compounds deposit. Then when cars are driven at higher speeds, three types of spark plug fouling can occur:

1. Spark gap bridging failure due to lodging of deposits between the plug electrodes, causing a direct short circuit.

2. Low shunt resistance resulting from deposits on the ceramic core which provide an alternate path for the electrical discharge. It is characteristic of this type of failure that the conductivity of the deposit increases with temperature. When the resistance falls below a certain critical value,

the potential developed across the plug electrodes is not sufficient to produce a spark at the spark gap.

3. Tracking, or surface discharge down the ceramic core, due to the presence of highly conductive material distributed discontinuously over the surface.

However, the solution to the automotive spark plug fouling problem may not be too far around the corner. Automotive, fuel, and equipment industry engineers know that the evil can be combatted in at least these four ways:

- Changing spark plug design.
- Changing ignition system.
- Using tricresyl phosphate as a supplementary lead scavenging agent.
- Proper servicing.

Right now, the question is: Which of these approaches offers the most? Which will do the best job, with the least drawbacks? Only more laboratory and field testing will tell. . . .

Spark Plug Fouling

type of electrode, it was hoped to get satisfactory high-speed life with the hotter type plug . . . which proved better from the slow-speed lead fouling standpoint.

This improvement, shown in Fig. 1, represented nearly a thousand more miles of foul-free operation. While not large, this mileage increase was enough to create some optimism.

This, then, led to a check of the hotter type plug on high-speed operation. It didn't show up too well. The production plugs were still satisfactory at 12,500 miles of high-speed operation, while the hotter plug had the center electrode completely burned to the porcelain at 7500 miles. (See Fig. 2.)

Changing the Electrode Material

The next step was to find out if improved performance could be obtained by changing the electrode material of the production plugs. Fig. 3 shows the results of this work. (The average for the production plug is repeated for reference.) One electrode change gave an average of 5800 miles of foul-free operation; the other 5200 miles. Tests on these two materials are still being conducted. To date, however, the high-speed endurance life of these two plugs has been considerably less than that of the production plugs.

Fig. 4 shows the results of changing electrode materials on the type B plug to obtain higher heat conductivity. The B-2 plug gave 8350 miles before missing; the B-3 plug ran 11,250 miles and still hadn't developed a miss. At present, tests are being conducted to find out if either of these plugs are satisfactory for high-speed operation.

Thus, extensive—but incomplete—field tests indicate that hot plugs do not foul as soon as cold

This abridgment is based on four papers presented at SAE National Passenger Car, Body, and Materials Meeting, Detroit, March 4, 1952: "Spark Plug Fouling from a Car Manufacturer's Viewpoint" by H. N. Metzel; "Spark Plug Problems in Automotive Service" by R. C. Beaubier, H. J. Chalk, and M. M. Roensch; "Spark Plug Fouling Studies" by R. J. Greenshields; and "Operation of Spark Plugs in Present-Day Engines" by H. H. Vogel.

The Greenshields paper will be printed in full in SAE Quarterly Transactions.

Each paper is available in full in multilithographed form from SAE Special Publications Department at 25¢ each to members and 50¢ each to nonmembers.

Table 1—Spark Plugs Tested

Type	Rating	Description
A-1	155 imep	Oldsmobile production
A-2	Approx. 155 imep	Similar to A-1 except for special electrode material
A-3	Approx. 155 imep	Similar to A-1 except for special electrode material
B-1	130 imep	Hotter plug than A-1
B-2	Approx. 130 imep	Similar to B-1 except for special electrode material
B-3	Approx. 130 imep	Similar to B-1 except for special electrode material

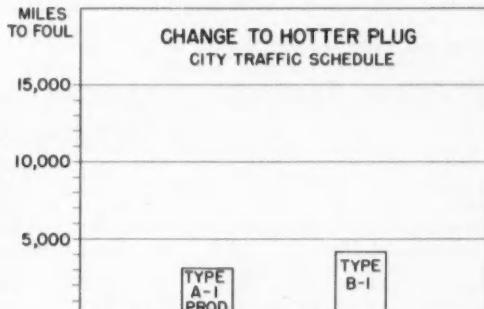


Fig. 1—Plug type B-1, one step hotter than the type A-1 production plug, gave nearly 1000 more miles of foul-free operation in city traffic service

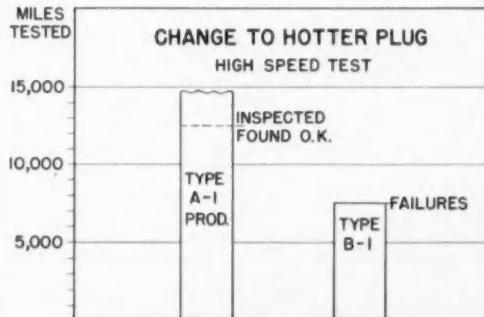


Fig. 2—The hotter type B-1 plugs didn't measure up as well as the type A-1 production plugs in high-speed tests

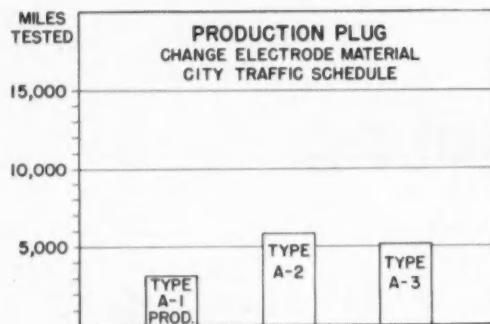


Fig. 3—Changing the electrode material of the production plugs improved their performance under city traffic conditions

ones in city traffic service . . . special high electrical-thermal conductivity electrodes in either type plug produce measurable improvement, especially in the case of hotter plugs.

There still remains the question, however, of

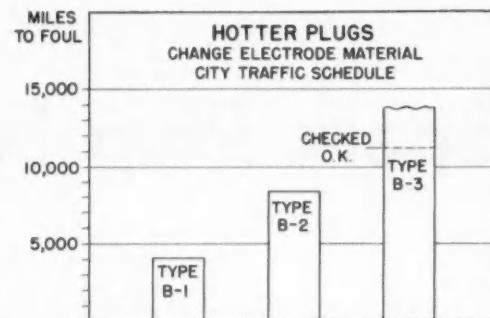


Fig. 4—Hot plugs equipped with special high electrical-thermal conductivity electrodes gave exceptionally good service in city traffic service

whether a plug that will offer improvement with respect to lead fouling will still be satisfactory for all around use. Many more thousands of test miles will have to be completed before any definite conclusion can be reached.

2. New Ignition Systems . . .

R. C. Beaubier, H. J. Chalk, and M. M. Roensch, Ethyl Corp.

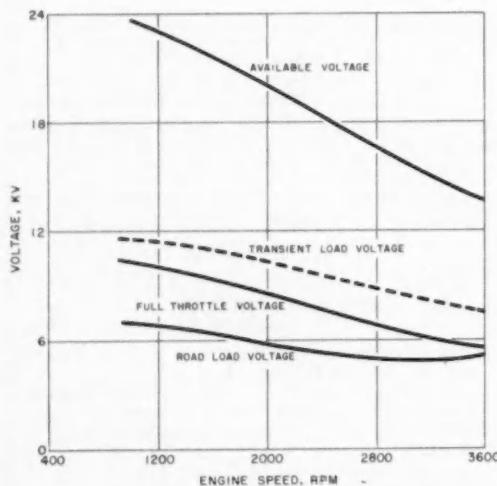


Fig. 1—Typical curves of voltage available with a standard 6-v ignition system and voltage required by spark plugs over the speed range of an 8-cyl engine

HIgh-frequency or 12-v ignition systems are possible solutions for the current passenger-car spark plug fouling problem.

Fundamentally, the failure of a spark plug to spark and ignite a combustible mixture of fuel and air is due to the voltage pulse from the ignition coil being too weak. Typical curves of the voltage available from a 6-v coil and the voltage required by spark plugs over the speed range of an 8-cyl engine are shown in Fig. 1. The margin between these two curves is ample when plugs are new. But, in service, many factors contribute to lowering available voltage and to raising the plug voltage requirement, and—where there is no margin between the two—plugs will fail to spark.

In fact, under some combinations of operating conditions, failure of spark may occur without any appreciable increase in voltage requirement. That's what happens when lead fouling occurs. In such cases the whole curve of available voltage is shifted downwards due to electrical leakage to ground over the surface of deposits that accumulate on the firing end of the plug insulator.

This situation is not improved by the standard 6-v ignition system, which has these two weaknesses. The voltage pulse from the coil does not rise high enough in relation to the plug's voltage requirement,

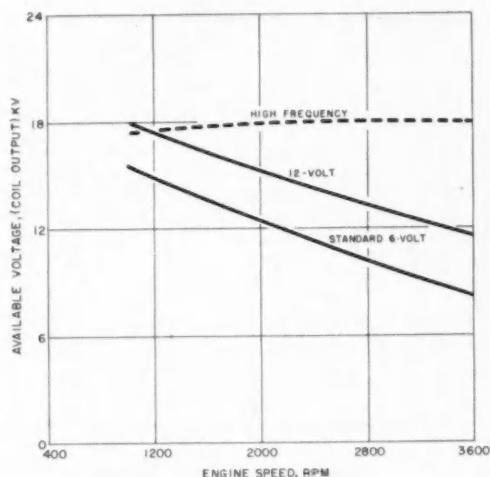


Fig. 2—Comparison of ignition coil output of high-frequency, 12-v, and 6-v ignition systems at various engine speeds

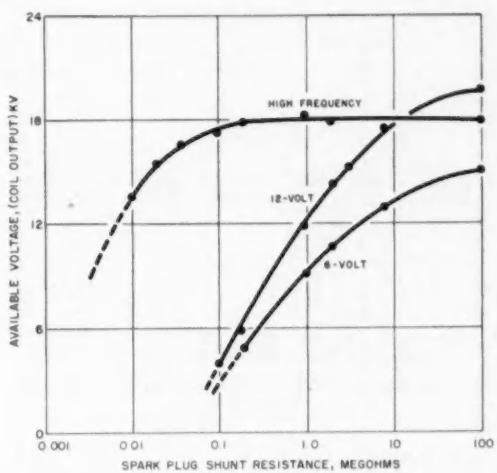


Fig. 3—Effect of spark plug shunt resistance on available voltage output of high-frequency, 12-v and 6-v ignition systems

especially at elevated speeds. Nor does it rise fast enough. This permits a serious loss of energy when shunt resistance is low . . . as is the case with fouled plugs.

Anything, then, that steepens the front of the voltage pulse will reduce spark plug fouling and anything that raises the crest of the voltage pulse (provides more voltage) should alleviate most spark-plug problems. That's where 12-v and high-frequency systems come in.

Use of 12 volts is one way of putting more energy through the primary winding at high speeds without overloading the breaker points at low speeds. And a high-frequency system provides a voltage rise at the electrode gap that can be many times faster than that found with the conventional 6-v coil.

A comparison of a high-frequency with a 6-v and a 12-v ignition system—all with 1.0 megohm of shunt resistance—is shown in Fig. 2. (A shunt re-

sistance of 1.0 megohm is considered borderline for satisfactory spark-plug performance for, although the plug may fire regularly, further reduction in shunt resistance will probably result in some misfiring.)

These data show that 12 volts provide the same available coil output at 3400 rpm as 6 volts do at 2200 rpm. They also indicate that this particular high-frequency system has a constant performance over the normal speed range, a distinct advantage.

A further advantage of the high-frequency system is illustrated in Fig. 3. Note that with high-frequency it is possible to fire a spark plug with a shunt resistance considerably below that which causes misfiring in a conventional 6- or 12-v system.

Since both 12-v and high-frequency ignition systems offer possible solutions to the spark plug fouling problem, experimental work on these systems should, and will, continue.

3. Tricresyl Phosphate as Lead Scavenger . . .

R. J. Greenshields, Shell Oil Co.

TRICRESYL phosphate greatly alleviates spark plug fouling. Field tests indicate that spark plugs operate twice as long before fouling when small quantities of this supplementary lead scavenging agent are added to the fuel.

Why does TCP act as a deterrent to lead fouling? This can be explained only by delving into the cause of spark-plug fouling . . .

In attempts to determine this mechanism, de-

posits from both fouled and satisfactory spark plugs were examined for possible differences that might explain fouling. Not only was the bulk of deposits on fouled and satisfactory plugs found to be identical, but also weight of deposit proved no indication of plug performance. Laboratory fouled plugs did, however, exhibit one unusual physical characteristic . . . gray-black glazed deposits on the nose of the plug. Subsequent work showed that these de-

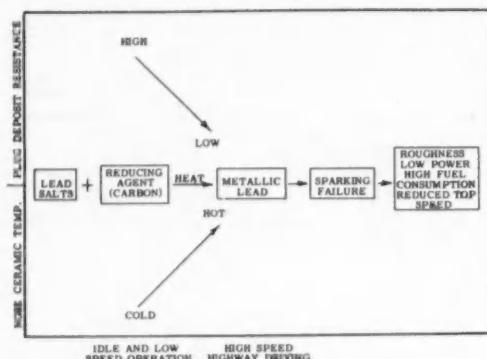


Fig. 1—Postulated mechanism of automotive spark plug fouling—metallic lead theory

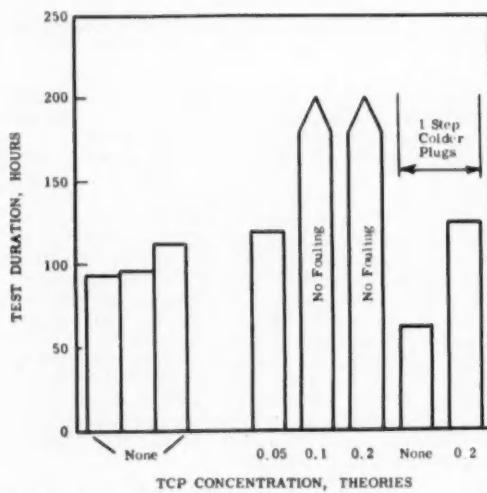


Fig. 2—Effect of tricresyl phosphate on spark plug fouling in a 1949 overhead valve V-8 engine

posits contained metallic lead; further checks suggested that these metallic lead particles were the cause of spark plug fouling.

The mechanism by which metallic lead is formed on spark plugs, subsequently causing misfire, is postulated to be as shown diagrammatically in Fig. 1. It involves: (1) deposition of lead salts on the plug ceramic due to incomplete scavenging; (2) mixing of carbonaceous material with the lead salts during periods of idle or rich mixture, or extended operation at such lean mixtures that incomplete combustion occurs; (3) heating of the resultant mixture by increased output operation, with the result that a certain proportion of the deposit is reduced to metallic lead; and (4) misfiring of the spark plug due to the possibly discontinuous, but excellent electrical conducting, path offered by the metallic lead particles.

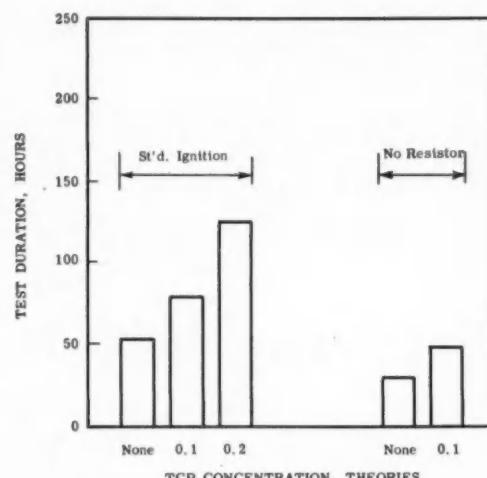


Fig. 3—Effect of tricresyl phosphate on spark plug fouling in a 1951 overhead valve V-8 engine

Accepting the metallic lead theory as the cause of spark-plug fouling, the mechanism by which TCP relieves fouling is believed to be fourfold:

1. *Formation and deposition of metallic lead is minimized:* Physical analyses of spark plug deposits from TCP fuel reveal little or no metallic lead. Further evidence that TCP minimizes metallic lead comes from tests on previously fouled plugs. These plugs were cleaned of all deposits except those on the tip of the center electrode ceramic, leaving a deposit that ran high in metallic lead content. The quantity of metallic lead present was found to be decreased substantially by the use of TCP fuel.

2. *Lead salts which have low electrical conductivity are formed:* Use of TCP in fuel results in the formation of lead phosphates and lead complexes which have low electrical conductivity.

3. *Deposits slough off readily:* TCP has a physical effect on combustion chamber deposits. Deposits are generally soft and powdery instead of the usual glazed form.

4. *Deposition of free carbon is reduced:* Use of TCP in unleaded fuel under conditions conducive to carbon formation decreased the deposition of free carbon. This would in turn minimize the reduction of lead salts to metallic lead.

Tests Show TCP Deters Fouling

An estimate of the value of TCP as a supplementary lead scavenging agent was obtained by laboratory testing four different automotive engines—two overhead valve V-8's, an 8-cyl overhead valve, and a 6-cyl L-head engine.

A study of conditions affecting spark plug fouling indicated that cyclic operation of the engines was necessary—that idle periods followed by light-load operation would bring about fouling in a relatively short time with reasonably consistent and valid results.

Spark plug fouling was determined by operating

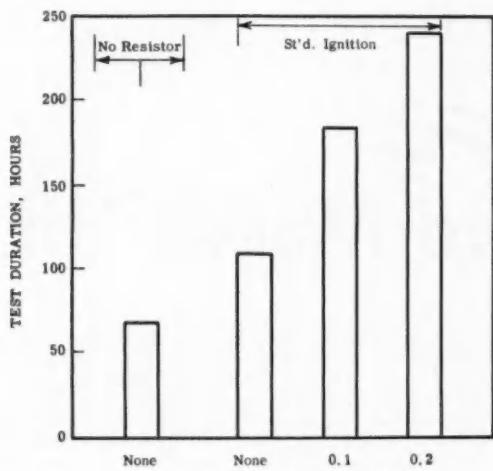


Fig. 4—Effect of tricresyl phosphate on spark plug fouling in a 1951 overhead valve 8-cyl engine

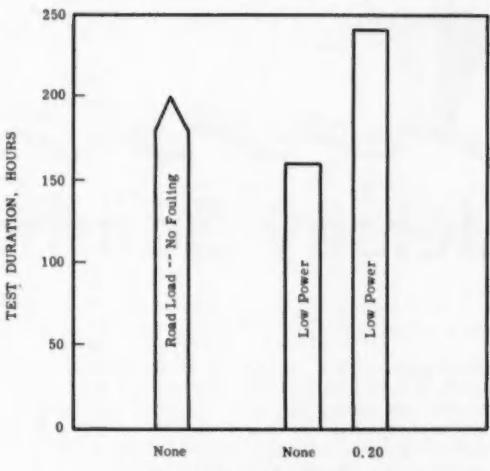


Fig. 5—Effect of tricresyl phosphate on spark plug fouling in a 1949 6-cyl L-head engine

the engine at full throttle, 3200 rpm and noting engine roughness, power loss, and—in several cases—backfiring. Checks were first made at 8-hr intervals; then more frequently as the test reached the critical point. The data obtained are shown in graphical form in Figs. 2, 3, 4, and 5.

Fig. 2 shows that fouling occurred in 94, 95, and 112 hr when commercially available gasoline containing 1.5 ml of tetraethyl lead per gal was used in a 1949 overhead valve V-8 engine. (This is illustrative of the reproducibility to be expected in such tests.) A TCP concentration of 0.05 theory had little effect. However, no fouling had occurred at 200 hr with 0.1 and 0.2 theories of TCP.

The performance of one-step colder spark plugs was also investigated in this engine. As expected, the plugs became fouled in about half the time.

Use of 0.2 theory TCP in the fuel doubled the life of these spark plugs.

Data obtained on the other overhead valve V-8 engine and the in-line 8-cyl overhead valve engine—both 1951 models—showed similar trends. (See Figs. 3 and 4.) Without TCP in the fuel, the V-8 engine fouled plugs on normal premium gasoline in 52 hr. Use of 0.2 theory TCP increased satisfactory operation time of the plugs to 126 hr. With the 8-cyl in-line engine, fouling occurred without TCP at 110 hr . . . with 0.2 theory TCP, the time was increased to 240 hr.

Thus, under the conditions employed, use of 0.1 theory TCP increased spark plug life about 75% and 0.2 theory TCP at least doubled the satisfactory operation period. What's more, limited field tests to date indicate that similar results are being obtained in actual service.

Proper Servicing . . .

Howard H. Vogel, Champion Spark Plug Co.

PROPER servicing still is, and will continue to be, an important path to improved spark plug performance.

The problem of spark plug installation has not been given enough attention by many car manufacturers and dealer service departments. Many times spark plugs are installed properly at the factory, then not properly reinstalled by dealer mechanics who remove the plugs to check them. This practice of improperly installing correct heat-range plugs leads to plug overheating . . . and a more serious deposit problem.

In conjunction with improper installation of spark plugs, the elimination of induced current between ignition cable is becoming more and more a factor with the use of higher compressions. Mechanics have gone so far as to grind valves, install new distributor points, and completely overhaul carburetors—when the only thing necessary to eliminate the engine skipping or missing was to separate the ignition cables.

The time is not too far off when the spark plug fouling problem will be overcome, but until that time arrives, it will be necessary to clean and test plugs more frequently.



Jersey Seashore Makes Hit

Continued from Page 17

at several sessions. New light was thrown on properties of titanium. It's been oversold as the miracle metal, advised one speaker. The new role of plastics as a material for models of motor vehicle components gave production men and designers food for thought. Because of their time and money-saving potential, plastic models were said to be opening a new approach to engineering and manufacturing planning.

There was word from the Petroleum Administration for Defense that petroleum products supply is adequate right now. But the industry has no reserve capacity in case of new emergencies—whether they be military ones or another Iran.

Automotive engineers stressed gasoline economy through equipment design. Transmissions tailored to engines were urged. The aim: to extract the full efficiency fuel-wise from modern powerplants.

Round table sessions again proved a popular Summer Meeting feature. Engineers were served up a varied technical fare at 14 of them. Complete Round Table reports will be published in forthcoming issues of the SAE Journal.

Lively question and answer periods followed the sessions at which this information was developed. Between sessions the one big question asked by most was: "Are we coming back to Atlantic City in '53?"

SAE Council approved the Meetings Committee's

answer before the week was out, and it was "Yes." Meetings Committee Chairman Ed Kelley explained that the facilities at both the Ambassador and Ritz-Carlton were adequate for handling the Summer Meeting. No comparable hotel setup in the country is available to accommodate the meeting. What's more, a great many members were pleased with the arrangements, noted Kelley.

Petroleum Supply Just Adequate

PETROLEUM supplies are generally adequate, said C. E. Davis in summarizing the world picture. Davis is now Assistant Deputy Administrator of the Petroleum Administration for Defense and has been a Shell vice-president in charge of refining operations.

But, Davis warned, there is virtually no cushion of reserve capacity to take care of any new emergencies.

We pay for our oil in steel coin, he said. About 11% of the nation's output of finished steel goes into the oil and gas business. Every day, old oil wells die and new wells—which are generally deeper and use more steel—must be drilled to replace them.

We have to run fast just to keep even. The only way to keep supply in pace with increasing demand is to provide for balanced expansion of all petroleum facilities together. That takes steel and lots of it, Davis pointed out.

In re-emphasizing the importance of steel produc-



THE AIR WAVES carried the story of the SAE Summer Meeting as told by President Barnard at a local radio station. He emphasized the free interchange of engineering ideas among men from a highly competitive industry



THE SAE STORY was told by General Manager John Warner in a slide talk to a Section officers' luncheon. The slides, which have been shown at several Sections, tell how the Society helps its members to create, grow, and advance together



As Site for Summer Meeting

tion during the discussion period, Davis reported that P.A.D.'s present program calls for drilling

- 25,000 wells during the last half of 1952, and
- 55,000 wells in 1953.

New facilities for tubular steel products will go into use late this year, Davis said. These ought to keep drillers well supplied.

Plastic "Toys" are Engineering Joys

CONFUCIUS said a picture is worth 10,000 words. Shop men will quickly agree to this when you're talking about engineering drawing. But at Ford they're saying one plastic model is worth 40 lb of blueprints. That's what Wallace A. Stanley, of the company's manufacturing engineering staff, told a session at The Ambassador.

Ford men found multiple gains from making newly designed parts and assemblies from plastic. They save time and money, and help improve engineering design, speed manufacturing and processing planning, simplify tooling design and materials handling planning, and aid purchasing.

Ford engineers were sold long ago on the effectiveness of parts models. But it took as long as three months to get hand-made models in steel. Plastic parts can be turned out within a few days after getting the drawings. What's more they cost about 1/25 as much as metal parts. In one case a

metal assembly cost \$4000 and took three months to make. The plastic assembly was produced for only \$150 and in just two days.

Stanley estimated that the switch to plastic models saved about \$500,000 in model costs on some 54 problems in just a few months. And that's a drop in the bucket compared to the millions Ford expects to save in the design phase and manufacturing preparation. The company sees these economies coming from six directions:

1. Time saved from getting programs under way in less time.
2. A cut in engineering man hours.
3. Fewer engineering changes.
4. Lower tooling costs.
5. Increasing participation and contribution of manufacturing suggestions.
6. Growing cooperation between engineering and manufacturing personnel.

This three-dimensional designing makes it easier to arrive at the final accepted design than flat "thinking on paper." Constructive design criticism and counter proposals are easy to see and make with models. With plastic it's easy to rework the design and produce a compromise. Manufacturing can be brought into the picture at about the same time as engineering product design, not after models, tools, dies, and fixtures have been completed.

At Ford, plastic model experience has proved that both engineering and manufacturing men come up



PLASTIC PROTOTYPE of automotive parts, said to be a big boon to Ford Motor, caught the eye of Rex Terry (left), of Creative Industries, and Fred Moskovics, of A. O. Smith Corp. Plastic parts save time and money in design and tooling



GENTLEMEN OF THE PRESS were at Atlantic City to record the meeting activities. Among them were (left to right): Joseph Geschelin, Automotive Industries; M. K. Simkins and R. L. Whealock, Commercial Car Journal; and J. R. Custer, Automotive Industries



with new ideas they normally didn't have until much later in tooling or production. It's the time to cut out unacceptable manufacturing items such as excessive costs and lack of machines and tools.

Processing engineers like plastic models because they can visualize clearly all the needed manufacturing operations and their sequence. Having the models in several cases helped engineers to see where they could combine several operations, drop others. Studying plastic assemblies has led to parts and machine standardization and wider parts interchangeability.

Plastic models also help show how to balance operations in time cycles. In one dramatic example, full-size sections in plastic revealed exact needs for welding gun accessibility, which guns should be used, exact location of spot pattern, and time to do all the operations.

Die designers find a model a big help in preparing tooling. Fixtures can actually be checked with plastic models. Materials handling men have been able to prepare special equipment months ahead with the plastic jobs. Machining specialists can visualize every metal forming and cutting operation, parts positioning, and machines needed.

Purchasing can use plastic models to get more realistic quotations than with blue prints. When people work with blue prints, they always add extras to tools and machines to allow for oversights and intangibles. Negotiations between buyer and vendor are handled with more confidence because both are talking about the same thing and can "see" all the problems.

Ford has found both full-size and scale models are useful. The 3/8 scale prototype takes less time and less material to make. Besides, it's easier to handle. Full-size models show true conditions for accessibility, stamping problems, and other things which might be misleading on a smaller scale. And full-size body and sheet metal parts can actually be put on a chassis and driven.

Crave "Mechanical" Dogs for Arctic Jobs

"MECHANICAL" DOGS may well prove the successors to the flesh and blood variety in Arctic climes . . . but first they'll have to come closer to matching a Husky's physiological equipment. Dog teams still remain the only prime movers that start at the crack of a whip in this severe low temperature area. And just as means must be found to insure easy starting of their replacements—small snow tractors, so must all military equipment be equipped to operate satisfactorily in the Arctic, stressed Col. William A. Call, of Detroit Arsenal, Ordnance Corps, at the Monday evening Truck and Bus session.

It's true that engines and batteries can now be

kept in good operating condition with accessory heaters. But the real solution to the problem lies in another direction—adapting the vehicles to the climatic conditions. A lot has been accomplished in this area, Call noted, but actually the surface has barely been scratched.

The Arctic fuel problem, for example, has partially been solved by the development of a gasoline which has a low distillation range and a high vapor pressure. And engine oils, gear lubricants, greases, and brake fluids are now available that measure up well even at -65 F. But low temperature efficiency of such components as primer systems, manifolds, carburetors, and ignition systems still has to be boosted.

What's more, Call emphasized, vehicles and engines will have to be made easier to maintain . . . for even the simplest maintenance job takes five times as long at -60 F as at 60 F.

And to make matters even tougher for designers, the guiding principle for all these efforts is to secure vehicles that can be manufactured at reasonable costs for service under normal conditions . . . that will still give satisfactory performance if suddenly transferred to the Arctic.

Symposium Tells How to Measure Wear

THE use of irradiated parts for the determination of wear rates has greatly accelerated studies concerned with the measurement and prevention of wear. Extreme sensitivity was reported for the new technique by C. C. Moore and W. L. Kent, Union Oil Co. of Calif., so that changes in wear rates occurring in only a few hours, and sometimes in only a few minutes, can readily be measured. As a matter of fact, it was estimated that the radioactive method is actually several hundred times more sensitive than the iron analysis method. Moreover, the engine is not dismantled to make radioactive wear measurements, so that mechanical factors should not influence wear values.

The method consists in running an irradiated part—usually a piston ring—in the engine for a certain length of time and determining the amount of radioactive material worn off.

That the method has satisfactory reproducibility was shown by F. W. Kavanagh of Calif. Research Corp., who ran both laboratory and long-time field tests with radioactive piston rings. In his field tests, 11 taxis were operated in normal city driving with the same oils as used in laboratory tests. The laboratory engine was operated under conditions usually considered representative of slow-speed, stop-and-go driving.

H. R. Jackson of Atlantic Refining found that, with radioactive top front piston rings in a fleet of



test cars, wear could be accurately determined after as little as one week's operation.

The Esso Laboratories are also using the radioactive tracer technique, according to J. F. Kunc, Jr., D. S. McArthur, and L. E. Moody of that company, in their studies of methods for reducing frictional wear in engines.

How Lube Oils Can Reduce Wear

As a prelude to discussions on the control of wear by the use of oils with special properties, V. G. Ravilo of Ford outlined the qualities of an oil essential to good lubrication. He said that the oil should be able to perform the following functions:

1. Lubricate properly, so as to prevent scuffing or galling of the surface, with consequent mechanical abrasion.
2. Provide some cooling of the surfaces.
3. Combat corrosion, such as the kind that attacks valves and guides, cylinder walls, and timing chains.
4. Have sufficient viscosity to provide some noise control—that is, the oil is used as a soft cushion between metallic parts.
5. Should not oxidize or decompose of itself.
6. Should not combine with other materials in the engine to form sludge and other deposits.
7. Should not change in viscosity—this particularly refers to the light oils made to meet, or to substitute for, the 5W specification.

The value of oils of high alkalinity in the reduction of corrosive wear was discussed by J. C. Ellis and J. A. Edgar of Shell.

Their tests showed that three conditions increased corrosion in the cylinder zone:

1. High load factors.
2. Low cylinder wall temperatures.
3. Fuels of 1% or more sulfur content.

However, high wear attributable to any or all of these factors may, according to their tests, be alleviated, in large part, by the use of a lubricant containing high alkalinity.

In one series of tests these authors ran, using a

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ARCTIC HEATERS for military personnel are examined by S. A. Kaye, Stewart-Warner, (left), and F. J. Opatrny, Perfection Stove. Three types are shown.



"IT'LL REPLACE DOGS," Colonel Call, Detroit Arsenal, is telling Frank Jones of Autocar in describing this small snow tractor. It's used to tow infantry sleds.



MECHANICAL MULE is used by the Ontario Department of Lands and Forests to cart supplies to lookout towers. The machine can be dismantled in less than 2 min. M. H. Baker, (left) and V. W. McMullen, of the Canadian agency, were at Atlantic City to tell onlookers about the vehicle.



Engineers Find Round Tables





Marketplace For Ideas





fleet of vehicles in city utility service, the wear rate was reduced over 50% by the use of this type of oil.

The advantages of heavy-duty oils for normal passenger-car operation was shown by tests reported by J. L. Palmer of the Lubrizol Corp. A fleet of 25 Chevrolet cars was used, the cars being assigned to company employees, who were instructed to use them as they would their personal cars, except for a few minor restrictions, such as, out-of-town trips limited to 200 miles and gasoline to be obtained from the same pump. After 15 months (approximately 14,000 miles of operation) the engines were torn down and inspected. The results indicated that the use of a heavy-duty crankcase oil (in the MIL-O-2104 quality range) accomplished the following effects (on the average) as compared with a nonadditive oil:

1. Reduced piston-ring wear 37%.
2. Reduced cylinder bore wear 42%.
3. Kept the engine cleaner. In terms of CRC merit ratings, the cleanliness was increased from 53 to 78.

Similar results were also reported by two other workers.

One was F. W. Kavanagh of Calif. Research Corp., who used radioactive rings in a laboratory engine run under conditions considered representative of slow-speed, stop-and-go operation. In these tests premium oil was better than one heavy-duty oil in the early stages but became poorer when it had been used too long. The other heavy-duty oil maintained a much lower wear rate than the other two oils throughout the test period, but the slope of the curve after the 20-hr point (equivalent to about 1000 miles) indicated that the additive had been consumed.

The effectiveness of high-additive oil was also shown by H. R. Jackson of Atlantic Refining, who ran a series of wintertime passenger-car tests in Philadelphia with oils of both high and low detergency.

This same investigator reported on other tests run with the low-viscosity, high V. I. Arctic oils (MIL-O-10295) since the CRC Arctic oil group had found that these oils give rise to increased oil consumption and wear, once normal engine temperatures are reached; the wear problem being particularly severe in certain 2-stroke-cycle multicylinder diesel engines.

These tests showed that the Arctic oils produced about seven times the wear of oils of conventional viscosity characteristics. The addition of 15% bright stock or antiscuff agents (chemical additives that react with metal wearing surfaces at high temperatures to form low shear films), however, reduced the wear of the Arctic oils to a normal level.

After pointing out that most of the test work was done in the low-temperature range, one member of

the audience asked how this fact affected the wear reduction shown in the papers. D. S. McArthur said that their tests showed high-temperature wear to be the most common type in the field.

In the tests run by his company, H. R. Jackson said the two oils used had the same base stocks and the same viscosity. There were no controls, he continued, on how the cars were driven and on trip lengths. He suggested that the majority of their cars showed overhaul reduction that could be explained only on a corrosion basis.

In reducing wear, V. G. Raviolo said, a large and substantial step is made when a partial flow filter is included in the lubrication system. The full flow filter, he added, is four or five times as effective, however, with no differences made in oil or oil change procedure.

H. G. Braendel, Wilkening Mfg. Co., said that his company has been eliminating temporary dry spots by making piston rings as conformable as possible.

It was also asked if wearing qualities could be improved when the water temperature is raised with the oil temperature kept low. J. C. Ellis replied that the reactions take place in the cylinder zone, that nothing happens to the oil in the crankcase, so the temperature of this oil would have no effect on wear.

Titanium's Justification is Strength/Weight

TITANIUM'S big advantage is its high strength/weight ratio. On this basis, titanium can replace aluminum and, below 1000 F, stainless steel, R. W. Parcel said.

Many of titanium's other characteristics, he explained, result from its affinity for oxygen, carbon, and nitrogen, which embrittle it. For example:

1. Titanium is costly to produce because air must be excluded and carbon crucibles are out of the question. Furnaces must have a layer of solid titanium between melt and wall.

2. Above about 1000 F titanium picks up the three contaminants so readily and loses strength so fast that it is useful only as a flame barrier—but very effective in that use.

3. The oxide film that titanium forms at room temperatures makes it completely resistant to salt water and appreciably resistant to chlorine and other bleaches.

Titanium forges satisfactorily at 1700-1800 F and rolls well at 1400-1600 F—the upper limits being set by oxidation and the lower ones by ductility. The pure-metal grades cold work without damage, with moderate strain hardening. Alloys can be cold worked about 25% between anneals. Commercially pure titanium can be welded with itself by processes

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SAE Romps at Gaslight Gayeties



BEFORE setting out for the Gaslight Gayeties, Mrs. Frederick S. Wood and Mrs. Daniel P. Barnard bestow smiles on Officer Barnard of the Gay 90's police force and the 1952 SAE presidency. Mrs. Wood is daughter of the Barnards.

Believe it or not, the mustachioed gentleman in the surrey with the fringe on top is Max Roensch. He posed with



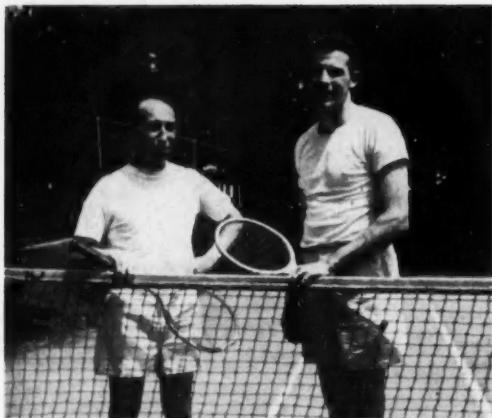
Mrs. Roensch just outside the Renaissance Room where the Gaslight Gayeties were in progress.

Inside, gay blades in bowlers danced with bathing beauties in black stockings and bloomers. And everyone had a good time singing old songs with Joe Howard and watching vaudeville acts, including one in which a magician proved L. F. Dumont to be bulging with coins.





Friends Got Together



NETMEN from Thompson Products, Emil Gibian (left) and Bob Ward, gave each other a workout on the tennis court



BOARDWALK BANTER was a popular activity. A serious thought is up for discussion by (left to right) Emil Cohn, Atlantic Refining; Ted Preble, Tide Water Associated Oil; and F. K. Glynn, American Tel & Tel



ANGLERS' APPETITES were satisfied, judging by the size of this catch in Atlantic City waters. These SAE fishermen are (left to right): Bill Creson, Jr., Bill Creson, Bob Steeneck, and C. H. Beach



in Talk and at Play



RUMP SESSIONS on matters ranging from powerplants to politics were in action throughout the meeting. Studying a blueprint are duPont engineers (left to right): A. S. Robinson, J. A. Rathburn, W. S. Powell, J. B. Hoyt, and E. B. Eipper



FUN FOR WIVES ran the gamut from Keno to fashion shows. The SAE ladies intent on their bridge game here are (left to right): Mrs. Charles B. Gale, Mrs. Daniel P. Barnard, Mrs. Frederick S. Wood, and Mrs. James G. Park



SWIMMING'S FINE, many found on taking a dip into the Atlantic. Among them were (left to right); F. E. Smith and S. A. Kaye, of Stewart-Warner, and Capt. R. J. Hefferson, Detroit Arsenal



that exclude air. Machining requires slow speeds, heavy cuts, positive pressures, and very sharp tools because of titanium's tendency to gall and its low thermal conductivity. Oxide scale, if allowed to remain on titanium, will quickly dull the hardest tools, Parcel warned.

Plentiful as titanium is, it will probably never be as cheap as aluminum or stainless because of production costs. But prices of titanium rods, bars, and sheet will probably drop to \$5-\$8 per lb within the next few years, Parcel predicted. He is with Rem-Cru Titanium, the corporation that Remington Arms and Crucible Steel formed in 1950.

In answering criticism of titanium's notch sensitivity, Parcel warned against selling the new metal short. Titanium processing gets better all the time, he said. And future improvements in surface finish, general purity, and freedom from defects can't help but raise notch strength.

F. E. Farrell of Rem-Cru and Crucible Steel reported that commercially pure titanium is now available in almost all the forms that stainless comes in. Titanium alloy is available in almost as many.

Why Batteries Are Best Yet . . .

BATTERIES today give better performance and last a lot longer, too—thanks to new, more efficient battery materials and component parts. Both cranking capacity and life have been upped as much as 50%. Electric Storage Battery's L. E. Wells told the group at the Tuesday morning Transportation and Maintenance session.

Steady development of more active plate materials, for example, has increased the cranking capacity of one battery 46% over the last 20 years.

Session Chairmen

Chairmen at the nine technical sessions of the 1952 SAE Summer Meeting were: W. E. Jominy—Monday morning session; B. F. Jones—Monday evening session; Linn Edsall—Tuesday morning session; G. M. Buehrig—Tuesday evening session; D. P. Barnard—Wednesday morning session; A. F. Underwood—Wednesday afternoon session; C. G. A. Rosen—Thursday morning session; W. G. Lundquist—Thursday evening session; and H. S. White—Friday morning session.

And use of thinner—but more—plates and separators has upped output well over 50%, Wells added. But this hasn't helped battery life, chimed in Mack's L. J. Heine. The trend toward thinner plates has gone too far. Too much life has been sacrificed to gain extra low temperature cranking performance, Heine claimed.

Battery manufacturers haven't been resting on their laurels here either, Wells went on to say. Life characteristics have been improved several different ways. Cycling life has been hiked 30 to 50% by using, in addition to the regular separator, an inactive material retainer against the face of the positive plate. New grid alloys resist corrosion (electrolysis due to overcharge), giving twice the cranking capacity during life as normal alloy grids. What's more, Wells added, these newly developed alloys reduce self-discharge of batteries while standing idle.

Lower specific gravity electrolytes give double-barreled aid. A 1.250 gravity battery not only begins to show better cranking ability after 25% of life than a 1.290 one, but it also lasts 40% longer. And that's not all, said Wells. Stand loss, too, is decreased 10% by dropping specific gravity from 1.280 to 1.260.

Engines Seek Ideal Transmission Mate

UP to now car owners have taken to self-shifting transmissions because they make for clutchless driving. The job now ahead for engineers is to come up with an automatic transmission that will cut the fuel bill, argued D. F. Caris and R. A. Richardson, of GMC Research Labs. They said the answer lies in a perfectly mated engine-transmission package.

The two researchers showed that coming high compression engines will give a 20% increase in fuel economy and an impressive performance gain. But before motorists can reap such an attractive harvest, engines will have to get transmissions they like.

The kind of transmission engines like is still in the dream stage. Caris and Richardson in effect asked the engine, through test evaluations. They found that it's a transmission which always adjusts the engine setting to operate at the point of minimum specific fuel consumption. This transmission of the future must act as a moderator . . . it has to keep the engine operating at best efficiency at all times to develop required power.

Comparing the ideal transmission with the standard one brings out these six facts about the power-transmission combination:

1. You get greatest economy improvement at road



Golfers Gather at Nineteenth Hole

1952 Champ



R. G. Wingerter

Runner-Up



Frank Farrell

Chairman



Bill Conway

Twosome



Jerry Ottmar (left) and
Bill Creson, Jr.

The Ladies . . .



Ladies' champion, Mrs. C. W. Kalchthaler, was camera shy. But this attractive foursome wasn't. They are, left to right: Mrs. R. G. Wingerter, Mrs. P. C. Ackerman, Mrs. H. B. Orr, ladies' golf chairman, and Mrs. J. C. Kyle

. . . Husbands and Wives



The golfing groups at the Seaview Country Club also included a number of Mr. and Mrs. combinations. Among them were (left to right): Mr. and Mrs. W. M. Fairhurst and Mr. and Mrs. W. H. Shealor



Boardwalk Briefs

Hot Stuff: The Meeting caught fire with the first session on Monday morning. As speaker J. J. Chyle was telling how to pick the right welding method, a line of smoke started curling up from the session room carpeting. Things got hot for a moment, until the smoke source was discovered. . . . The 1000-watt slide projector was hooked up to a light lamp wire that was smoldering under the carpet.

★ ★ ★

Hit or Miss: "Don't be fooled by averages," warned Lee Wells, of Electric Storage Battery. He told of the hunters who fired 400 shots at a flying duck—200 exactly 3 ft in front of the bird and 200 exactly 3 ft behind it. Statistically the creature was deader than a doornail. But the duck couldn't figure averages and flew merrily on its way.

★ ★ ★

Blessed Event: The big grin Ed Stilwill carried all week is easy to understand. On Tuesday Ed's son phoned from Camp Atterbury, where he is an orthopedic surgeon, to announce the birth of Richard Stilwill, Ed's fourth grandchild.

★ ★ ★

Daffy Definition: An expert is a dumb guy a long way from home, said Fred Potgieter, vice-president of Mechanics Universal Joint.

load. (It was shown to be 90% in one example.)

2. Economy improvement quickly diminishes at greater loads.

3. The driver continually operates between road and performance power. So his overall tank mileage gain will be much less than the theoretical top of 98%.

4. Country and city types of driving will have a greater effect on fuel economy with the ideal transmission. But there will be some improvement under all conditions.

5. Road load economy is independent of performance with the ideal transmission. With the standard transmission, the greater the performance, generally the lower the road load economy.

6. The higher the performance factor, the greater the economy gains from the ideal engine-transmission team.

Transmission engineers agreed with the engine men as to the pay-off in the offing from a "perfect" drive. Setting up a goal is one thing, but creating a machine that does the desired job is somewhat tougher. The road to the ideal transmission will be rife with engineering trials and tribulations.

How to Choose a Welding Process

THERE are eight general factors to consider in selecting the most suitable of the 37 different welding processes now known, according to John J. Chyle of the A. O. Smith Corp. Chyle's list comprised:

1. Design and Service Requirements of the Product—These include the magnitude and distribution of the loads or stresses, whether oil or water tightness is required, presence of corrosives, expected life, appearance demands, temperatures encountered, electrical and thermal conductivity needs, and magnetic properties desired.

2. Characteristics of Welding Processes—Some processes just aren't suited for some applications. For example, gas welding isn't practical for welding large masses of metal.

3. Characteristics of Welds Made by Various Processes—Welds made by various processes show differences in strength, size, and shape.

4. Composition of Metals to be Welded—Some metals, like carbon steels, can be welded by most of the known processes. Other metals can't. With titanium and its alloys, only inert-gas arc welding and a few of the resistance welding processes are usable at present.

5. Welding Joint Design—Most welding processes are suitable for only certain types of joint. Flash welding, for instance, cannot be used with lap



joints, and resistance welding is not applicable to fillet joints.

6. Production Rate—It takes a high production rate to justify expensive equipment such as is needed for flash welding.

7. Power Availability—For large resistance welding machines, the electric power source must be sufficient to meet high current demands. Locations where electric power is unavailable or very expensive call for processes like thermit welding which involve nonelectrical heat sources.

8. Economics—Cost factors include costs of preparation, set up, labor, material, power or heat energy, equipment, and finishing.

In the discussion period following his paper, Chyle answered questions about the fatigue and endurance strengths of welds. He warned that to reduce likelihood of fatigue failures, welds should be located only in areas of little flexure and then inspected carefully after completion for flaws. The weld metal should be the same as the parent stock. A. O. Smith's welded hollow SAE 4340 propellers, he said, have increased section thickness at the weld to improve fatigue strength.

Fred Moskovics noted that Allis-Chalmers applies 2000 psi pressure to turbine bucket welds after welding. Chyle explained that this is another way of improving fatigue strength. The force applied induces favorable compressive stresses.

Chyle told Walter Jominy of Chrysler that the ratio of endurance strength to tensile strength runs about $\frac{1}{2}$.

New Military Drive a "Stack of Pancakes"

A "PANCAKE" engine . . . that's what the military got when it asked General Motors to develop a compact and lightweight 16-cyl diesel engine, General Motors' Eric R. Brater told the engineers gathered at the Thursday morning Diesel Engine session.

Extremely economical use of space is obtained with this vertical-crankshaft, radial engine, Brater explained. It's mounted on its gear box, and its sixteen $6 \times 6\frac{1}{2}$ in. cylinders are stacked like pancakes in banks of four cylinders each.

One of the unique features of the engine is its slipper-type connecting rod bearings. These permit attaching four connecting rods to a single crankpin, and provide one more way to keep engine weight and size down.

Other design features, Brater went on to say, include a barrel-shaped crankcase built up entirely of steel forgings which are welded together, main bearings that can be removed without disturbing the crankshaft, and 30 air intake ports.

Boardwalk Briefs

Monkey Shines: The roguish little monkey who played mascot of the Gay Nineties festivities caused great consternation on the big night. The little rascal flew the coop. Unable to find his simian sidekick, the master left for New York broken-hearted. A vigilante committee set out on the hunt and uncovered the missing monkey hidden in the hotel rafters. With a little food and a little coaxing, he came back to his cage. Ladies who reported being accosted by an ape can rest assured it was only this friendly little fellow who lost his way.

★ ★ ★

No tickee, no laundry: That's pretty much what the room clerk told President and Mrs. Barnard, when they tried to check in at the Ritz-Carlton. "We have no reservation for you and have no space available here," the hotel told Dr. Barnard, even after he noted he was president of the Society holding its meeting there. The growing crisis was broken by calling the Ambassador across the street and finding that accommodations had been arranged there for SAE's boss man and first lady.

★ ★ ★

One for Webster: "Since language standardization is our business," said the SAE Commercial Vehicle Nomenclature Committee, "let's first get unity on how to pronounce the name of our own Committee." It's NOmenclature, not noMENclature, they agreed almost unanimously. Chief dissenter, Merrill Horine, refused to surrender a long-standing speech habit, facetiously labelling the Committee's action as a curb on his freedom of speech.



HARRY F. VICKERS, founder and president of Vickers, Inc., Detroit, has been elected president of the Sperry Corp. He has been associated with Sperry since 1937, when Vickers, Inc., became a Sperry subsidiary. He will continue to serve as president of Vickers.



KENNETH R. HERMAN, vice-president and general manager and a director of Vickers, Inc., has been elected a vice-president of the Sperry Corp. Herman will continue in his present capacities at Vickers, with which he has been associated since 1931.



MILTON J. KITTLER, who was vice-president of engineering of Holley Carburetor Co., Detroit, has been elected executive vice-president. Kittler joined Chandler-Grove Co. in 1935 as head of aircraft carburetor engineering and continued in that capacity when the company merged with Holley in 1938. He was made vice-president and chief engineer for the aircraft division in 1944, and vice-president and chief engineer for both the automotive and aircraft divisions in the following year.



CHRISTOPHER DYKES is now a consulting aeronautical engineer, with offices in London, England. Until the end of 1951, he was chief engineer, development, of British Overseas Airways Corp.; for 3 years he had been in charge of all new aircraft and equipment for B.O.A.C., including the deHavilland "Comet" and the Bristol 175 aircraft. Dykes was B.O.A.C.'s plant representative on the Stratocruiser Project at Boeing in 1946, and has spoken at several SAE meetings.



WILLIAM F. LEFEVRE, JR., has been named chief engineer of Freightliner Corp., Portland, Ore. LeFevre served eight years with Boeing in Seattle as research engineer on structural development and gas turbine projects concerned with light metals and stress problems. In 1941, he was research engineer for the Missouri State Highway Department.

About

PAUL C. JOHNSON has been elected president of Sealed Power Corp., Muskegon, Mich. Johnson has served as executive vice-president of the corporation since 1948. He started with the company in 1929 and was elected vice-president in charge of sales in 1941.

WILLIAM V. KERSHOW has been appointed technical service manager for Willys-Overland Motors, Inc., Toledo, Ohio. He was previously assistant technical service manager. Kershaw succeeds **DEAN A. WALTERS**, who has been named special assistant to the general parts and service manager. Walters has been director of service for the company since 1935. He has been with Willys-Overland for 43 years.

FRANK L. DeCAVITTE has been named to the newly-created post of operating manager of Chrysler's Plymouth Division. DeCavitte has been associated with Plymouth since the division was formed in 1928, and has been factory manager in Detroit since 1948. **ROY W. VORHEES** will succeed DeCavitte as factory manager. Vorhees, who has been assistant factory manager since December, has been with various divisions of Chrysler Corp. since graduating from Colorado A and M in 1938.

WILLIAM A. TRAUT has left Blackhawk Mfg. Co., Milwaukee, Wis., where he was chief industrial engineer, to offer consulting engineering services in McAllen, Texas.

GEORGE A. ZINK has been appointed general manager of the Fabricast Division of General Motors in Bedford, Ind. Zink, who has been assistant general manager of the division since March, joined GM's Allison Division in 1929, and became works manager for Detroit Diesel Engine Division in 1943.



Members

ROBERT T. KELLER has been named general manager of tank manufacturing operations for Chrysler Corp. in both Delaware and Detroit, where plans are under way for Chrysler to take over tank production at Detroit Arsenal. Keller has been general manager of the Chrysler Tank Plant at Newark, Del., and now has responsibility for both programs. He has been with Chrysler since 1934 in a variety of manufacturing and executive posts, including president of the company's Marine and Industrial Engine Division since 1948.

JOHN C. BUCKWALTER has been named chief engineer at the Long Beach, Calif., plant of Douglas Aircraft Co., Inc. Buckwalter was previously assistant to Douglas' vice-president of engineering at Santa Monica, Calif.

GORDON BROWN, vice-president of the Bakelite Co., a division of Union Carbide and Carbon Corp., has been reelected president of the Society of the Plastics Industry, Inc. Brown, whose second term of office began June 1, was a founder of the plastics society fifteen years ago.

W. F. MOORE has been named Aviation Department manager in the Pacific Northwest District for General Electric Co. He will make Seattle, Wash., his new headquarters. Moore was previously in Schenectady, N. Y., as project engineer responsible for the application of all General Electric equipment on the Boeing B-52 and B-47.

ERNEST B. MANSFIELD has joined Phillips Chemical Co., Pasadena, Calif., as supervisory mechanical engineer. Mansfield was previously assistant project manager and chief engineer on tank study for Brown and Root, Inc., Houston, Texas.

ROBERT C. GUNESS has returned to Standard Oil Co. (Indiana), Chicago, Ill., after having served as vice-chairman of the Research and Development Board of the Department of Defense. Gunness, who prior to that was manager of research for Standard, is now assistant general manager of manufacturing.

ANDREW F. HAIDUCK, vice-president of Lear, Inc., is now also general manager of the corporation's Grand Rapids Division. He previously managed the company's Romec Division, Elyria, Ohio.

CHARLES W. PERELLE, president of ACF-Brill Motors Co., was awarded the honorary degree of Doctor of Business Administration by St. Joseph's College, Philadelphia, on June 1, for his contributions to industrial development in Philadelphia.

New Assignments at Chevrolet Division



H. F. Barr

Major changes in GMC Chevrolet Division's engineering staff have been announced by **EDWARD N. COLE**, new chief engineer. **H. F. BARR**, assistant chief engineer at Cadillac, transfers to Chevrolet to head engine and passenger car chassis engineering and experimental proving ground engineering. **E. G. SPRUNG**, who was chassis engineer, becomes assistant chief engineer for truck chassis engineering.

MAURICE OLLEY returns from England, where he was chief resident engineer at GM's Vauxhall Motors, to fill the new post of director of research and development. He will be assisted by **M. S. ROSENBERGER**, who has been assistant engineer in charge of GM Product Study 3.

Assistant Chief Engineers **E. J. PREMO** and **C. W. FREDERICK** also take new responsibilities: Premo will direct passenger car and commercial body styling and engineering, and Frederick will be in charge of production and field product engineering and the aviation engine project. The revised staff will report to **P. A. COLLINS**, recently appointed executive assistant chief engineer.



Maurice Olley



ROBERT CASS (left) succeeded **COURTNEY JOHNSON** (right) as director of the Motor Vehicle Division of the National Production Authority. Johnson has returned to his position as assistant to the president of Studebaker Corp. Cass, who was deputy director, is on leave from the White Motor Co.

E. E. ZIMMERMAN is now supervisor of the electrical and mechanical laboratories at the Tank Engine Division of Chrysler Corp., New Orleans, La. He was formerly with Chrysler Engineering Division in Detroit as project engineer in the sound and vibration laboratory.

HARRY M. DENYES is now with Ross Tool and Gear Co., Lafayette, Ind., as Detroit sales representative, with offices in Detroit. Denyes was previously sales manager of Gemmer Mfg. Co.

T. F. SHARP is now plant metallurgist at Morse Chain Co., Ithaca, N. Y., a division of Borg-Warner Corp. He was previously assistant to the general manager of Borg-Warner's Products Development Laboratory in Detroit.

CHARLES F. KETTERING received the annual award of the New Jersey Patent Law Association at a dinner in his honor on May 8 in Newark.



STANLEY W. STEPHENS has been named manager of Diesel Electric Service and Supply Co., a new division of Koepsel and Love, Inc., Salt Lake City, Utah. Stephens, who was previously field service engineer for Koepsel and Love, is chairman of SAE's Salt Lake Group.



GEORGE D. SHERMAN has been named president of Orion, Inc., Bay City, Mich. Sherman was formerly with American Brakeblok Division of American Brake Shoe Co., Mallory Electric Corp., and U. S. Rubber Co., and was gasket engineer for Wolverine Fabricating and Mfg. Co. for more than 12 years.



HARRY KOTTAS is now on the staff of the chief of the technical and engineering division of Redstone Arsenal, Huntsville, Ala., to advise on guided missiles and rockets. Kottas was formerly chief of the mechanical engineering division of Lewis Flight Propulsion Laboratory of NACA.



J. V. KOSKI has been appointed chief engineer of the International Metal Hose Co., a division of Gabriel Co. Koski has been chief draftsman for Gabriel for the past seven years.



JOSEPH V. KIELB has joined Tenney Engineering, Inc., as production manager of the company's two plants in Newark, N. J. Kielb was previously works manager for King Refrigerator Corp., Kew Gardens, Long Island, N. Y.

ALBERT J. BLACKWOOD, assistant director of research of Standard Oil Development Co., recently travelled to South America to confer with Standard affiliates. The 18,000-mile jaunt included Havana, Caracas, Maracaibo, Bogata, Lima, Santiago, Buenos Aires, Montevideo, Rio de Janeiro, and Trinidad. Writing from Rio, Blackwood praised Latin hospitality, Santiago lobster . . . and the thrill of flying through the Andes, rather than above them.

DR. KENNETH G. MACKENZIE of the Texas Co. was named chairman of the June 12-14 meeting of the International Organization for Standardization Technical Committee 28—Petroleum Products. Other SAE members among the American delegation were **A. E. BECKER**, **R. S. BURNETT**, **J. T. MCCOY**, and **C. O. TONGBERG**. ISO/TC 28's sessions were held at Columbia University in conjunction with the 1952 triennial meeting of ISO.

EDWIN A. PECKER is now with Burton Mfg. Co., Los Angeles, Calif., as project engineer and administrative assistant to the chief of production. Pecker was previously an independent consultant.

PRESTON M. POSTLETHWAITE has been appointed assistant manager of the New York automotive branch of Wagner Electric Corp. in Jersey City, N. J. Postlethwaite, who was formerly manager of the automotive and electrical departments at Wagner's branch in Portland, Ore., joined the company in 1937 as a student engineer.

ELROY PENNER is now with Pacific Pumps, Inc., Huntington Park, Calif., as a test engineer. Penner was formerly at the Air Force Flight Test Center at Edwards Base as project engineer on aeronautical powerplants.

HARRY J. SCHROEDER is now design engineer for Food Machinery and Chemical Corp., San Jose, Calif. He was previously with Allis-Chalmers Mfg. Co., Springfield, Ill., as draftsman.

ALFRED L. BOEGEHOOLD, assistant to the general manager of GM Research Laboratories, has announced development by GM of "Aldip", a new dipping process for coating steel and other ferrous metals with aluminum. Boegehold, who participated in work on the new process over a six-year period, said that it may replace zinc-coated metals as a corrosion or rust resistant coating for ferrous metals in some applications. When diffused by heat treatment, Aldip becomes heat resistant, he said, and thus may conserve a number of strategic alloys now used in high temperature applications.

JOHN K. RUDD has been promoted to chief research engineer of Richardson Scale Co., Clifton, N. J. Rudd, who joined the company in 1948, was previously project engineer.

WILLIAM L. MIRON has been appointed general foreman of inspection at the new Michoud Ordnance Plant of Chrysler Corp. in New Orleans, La. Miron was previously tool engineer for Chrysler in Detroit.

JAMES L. HAYNES is now on special assignments for GMC's Hyatt Bearings Division, Harrison, N. J. Haynes was previously division engineer for the company in Chicago.

R. D. HOLBROOK has been named chief production engineer at Chrysler's Jet Engine Plant, Detroit. He was previously assistant accessory engineer for Chrysler.

BRUNO E. STECHBART, JR., is now a sales engineer for the industrial chrome division of Ward Leonard Elect Co. at the Chicago office. Stechbart was formerly design engineer for the Automatic Transportation Co. in Chicago.

H. G. VESPER, president of California Research Corp., San Francisco, has been elected to the board of directors of the Industrial Research Institute, Inc., New York City.

ROBERT W. McFARLAND is now partner in the C and L Motor Co., San Jose, Calif. McFarland was formerly owner of Bob McFarland Truck and Trailer Co. in Portland, Ore.

JACK D. MATTHEWS is now with Continental Motors Corp., Detroit, as test engineer. He was previously junior experimental engineer for Willys-Overland Motors, Inc., in Toledo, Ohio.

S. A. SADIQ is now a deputy director of the Government of Pakistan's Central Engineering Authority, the central organization for the development of power resources in Pakistan. Sadiq was previously executive engineer for the Pakistan Public Works Department.

A. FRED ANDERSON, who was formerly factory manager of the west coast plant of Thompson Products, Inc., in Bell, Calif., has been named sales manager of the west coast plant. **PAUL W. SHEEHAN** will work with Anderson as assistant sales manager.

A. E. SNYDER has completed graduate study at Princeton University and is now project engineer on diesel engine research at the industrial power division of International Harvester Co., Melrose Park, Ill.

JOHN GITZ has rejoined Republic Aviation Corp., Farmingdale, N. Y., as director of the company's foreign licensee program. Gitz has been with Chase Aircraft Co. as chief production engineer. He was previously chief engineer of Republic's Indiana Division and chief production engineer at Farmingdale. Gitz served as Philadelphia Section's vice-chairman for aircraft in 1950-51.



EUGENE V. IVANSO has joined the CO₂ Development Co., Detroit, as associate and engineering consultant. Ivanso was previously metallurgical engineer for Steel Sales Corp., and prior to that was chief metallurgist at Wyandotte Chemicals Corp. and research metallurgist for Bundy Tubing Co.



NORMAN G. SHIDLE, editor of the SAE Journal, was awarded the honorary degree of Doctor of Laws by Occidental College, Los Angeles, on June 9.



K. G. MacKENZIE, Texas Co., (left) and SAE President **D. P. BARNARD** (right) were presented with resolutions of appreciation from the Board of Directors of the Coordinating Research Council for their past services on the Board. **M. K. McLEOD** (center) is manager of CRC.

SAE Members Are Saying . . .

"The Arlington plant of the Buick-Oldsmobile-Pontiac Assembly Division is General Motors 113th plant in this country. It is also an important 'first' because it is the first dual-purpose plant to be built by GMC. This is a dual-purpose factory because it can be used in more than one way: for combined defense and commercial production, for all-out defense, or for total civilian production." . . . John F. Gordon, vice president of General Motors, at the Chamber of Commerce of Arlington, Texas, May 27.

"A word which is often overrated is tolerance. It implies a mental reservation, is negative, connotes a grudging acceptance of a person who is not really regarded as an equal. Brotherhood implies no limitations. It is positive in every respect. It connotes recognition of every man as the brother of every other man and, therefore, an equal." . . . Harvey S. Firestone, Jr., chairman of Firestone Tire and Rubber Co., in accepting citation from Massachusetts Committee of Catholics, Protestants, and Jews.

"The way to eat an elephant is to cut it up into small pieces and feed the pieces to a whole lot of

ALVIN E. CONANT is now service representative in Los Angeles for GMC Buick Motor Division. Conant was previously claims manager at the Los Angeles office.

REBA W. RUIZ is now with the systems and tactics division of North American Aviation, Inc., Los Angeles, as aerodynamicist. She was formerly mathematician for Consolidated Vultee. Mrs. Ruiz is the former Reba Vemich.

CLARENCE E. MORPHEW is now at the Cleveland Tank Plant of Cadillac Motor Car Division as staff engineer in charge of turret, armament and stowage. He was previously in Detroit as senior project engineer in Cadillac's sheet metal department.

people." That's how C. E. Wilson, president of General Motors, suggested attacking materials handling in the automotive industry.

"All experience shows that simple economic controls become steadily more complicated. It's not because the controllers are involved in any plot to make them so, but because a highly technological society cannot be confined to strait-jacket rule-making and control and remain dynamic and progressive." . . . Ernest R. Breech, executive vice-president of Ford Motor Co., in an address to the Detroit Aircraft Club.

"The danger that a rubber cartel may be established stems from the fact that leaders in certain nations believe it may be possible to eliminate or reduce uncertainties of rubber production. Instead of restricting production, we should make every effort to expand consumption. High prices restrict the use of rubber; low prices encourage its use." . . . John L. Collyer, president of B. F. Goodrich Co., in a talk to the National Association of Purchasing Agents at Atlantic City, May 27.

TEDDY ONGARO is now vice-president of the International Research and Development Corp., Columbus, Ohio. Ongaro was previously vice-president of Lion Mfg. Co. in Columbus.

CLARENCE E. MORPHEW of GMC's Cadillac Motor Car Division has been transferred from Detroit to Cadillac's Cleveland Tank Plant.

WILLIAM CLOSE has joined the flight research department of Cornell Aeronautical Laboratory, Buffalo, N. Y., as research mechanical engineer. He was formerly with A. V. Roe Canada, Ltd., in Malton, Ont.

B. V. RONCO has joined the International-Plainfield Motor Co., Plainfield, N. J., as chief inspector. Ronco was formerly chief engineer of Morrison Steel Products, Inc., and prior to that was with Mack Mfg. Co. for 25 years in various engineering and inspection capacities, including chief engineer.

FRANK H. FUNKE, who was general manager of the Donaldson Co. (Canada), Ltd., in Chatham, Ont., is now general manager of Donaldson's Grinnell Division, Grinnell, Iowa.

HARVEY D. FERRIS is now field service representative for Aircooled Motors, Inc., in Fort Worth, Texas. Ferris was previously industrial foreman for Lewin Metals Co. in East St. Louis, Ill.

D. STUART BLACKMORE, who was sales technical representative for Shell Oil Co. of West Africa, Ltd., in Lagos, Nigeria, is now in Canada as industrial and commercial sales representative for Shell Oil Co. of Canada, Montreal, P.Q.

HENDRIX R. BULL, who was an engineering draftsman for the Kettelman North Dome Association, Avenal, Calif., has been promoted to assistant chief engineer.

JOHN J. FRANZMAN is now with Crown Central Petroleum Corp., New York City, as general sales manager of the branded lubricants department. He was previously with Cities Service Oil Co. (Pennsylvania) as manager of the wholesale lubricants department.

OLLE SCHJOLIN has been named director of engineering of Ford Motor Co., Ltd., Dagenham, Essex, England. He was previously chief engineer.

CLARENCE G. WOOD is now an industrial specialist for U. S. Army Ordnance in Cleveland, Ohio. Wood was formerly vice-president of Karyall Body, Inc., in Cleveland.

R. E. STRASSER has joined the William R. Whittaker Co., Ltd., Hollywood, Calif., as design engineer. He previously held the same title with Hydro-Aire, Inc., in Burbank.

JOHN F. GORDON, vice-president and group executive of General Motors Corp., has been elected chairman of the board of regents of General Motors Institute, Flint, Mich.

HERMAN H. BEMENT is now aircraft maintenance engineering officer aboard the U.S.S. Antietam. Prior to joining the Navy, Bement was with Grumman Aircraft Engineering Corp., Bethpage, N. Y.

JOHN J. CYCHOL, JR., who was previously assistant construction engineer for E. A. Meyer Construction Co., North Chicago, Ill., has joined Caterpillar Tractor Co., Peoria.

VET V. HOLMES is now a research engineer at the Santa Monica, Calif., plant of Douglas Aircraft Co. He was previously an instructor in mechanical engineering at the University of Wisconsin, and has just received a doctor's degree in mechanical engineering from the University.

RICHARD L. HUNT has been promoted to engine specialist for the export department of Worthington Corp., Harrison, N. J. Hunt was previously sales engineer for Worthington's engine sales division at the Buffalo, N. Y. works.

CAPT. ARTHUR R. CHASE is now commanding officer of the 937th Ordnance Heavy Automotive Maintenance Company. Captain Chase was formerly operations officer for the Climatic Test Detachment at Devil's Lake, N. D.

DOUGLAS L. SCHULTZ, who was formerly manager of the road test laboratory of E. I. duPont de Nemours in El Monte, Calif., has been transferred to duPont's petroleum laboratory in Penns Grove, N. J., as research engineer.

ANDREW C. McDERMOTT has joined Consultants and Designers, Inc., New York City, as stress analyst at Goodyear Aircraft Corp. He was previously with Harper Engineering Co. in Dallas, Texas.

JOHN D. MARK is now engineering draftsman for Paxton Engineering Co. in Los Angeles, Calif. He formerly held the same title with Hughes Aircraft Co., Culver City, Calif.

BERNARD M. SCHWALM of Union Oil Co. of California has been transferred from Stockton, Calif., to the company's offices in Rockefeller Plaza, New York City.

JAMES L. GILLIS is now with Lockheed Aircraft Co., Burbank, Calif., as research engineer. He was previously junior project engineer with GMC AC Spark Plug Division in Milwaukee, Wis.



HAROLD W. HALL (right), who was formerly general service manager of Cummins Engine Co., Inc., has been named general manager of Cummins Diesel Export Corp. His former post of general service manager will be filled by **CHARLES C. SONS** (left), who was previously eastern service manager. Here they confer on service policy at Cummins headquarters in Columbus, Ind.

CLARENCE E. HOLTSINGER, JR. is now general manager of Clearwater Lincoln-Mercury Co., Inc., in Clearwater, Fla. He was formerly with Pratt and Whitney Aircraft Division of United Aircraft Corp., East Hartford, Conn., as assistant licensee liaison engineer.

CAPT. R. W. PECAUT is now stationed at Lima Ordnance Depot, Lima, Ohio, as personnel officer and adjutant. He was previously assigned to the Korean Military Advisory Group.

JOHN F. ROJC is now with GMC Electro-Motive Division, La Grange, Ill., as senior designer. Rojc was formerly with International Harvester Co. as layout draftsman.

JAMES F. SULLIVAN, JR. is on leave of absence from Utah Oil Refining Co., Salt Lake City, to serve with the U. S. Naval Reserve. Lieutenant Sullivan is stationed at the Naval Air Material Center, Philadelphia, Pa.

THOMAS J. F. SHERMAN has joined Consolidated Vultee Aircraft Corp., San Diego, Calif., as design engineer. He was previously in charge of development for the Votator Division of the Girdler Corp., Louisville, Ky.

CAPT. ROBERT L. EDNIE of the U. S. Army Corps of Engineers has returned from service in Korea and is stationed in Omaha, Nebr.

HERBERT NEAL BERGE has joined Reo Motors, Inc., Lansing, Mich., as designer in the lawnmower division. Berge was previously designer for the Clinton Machine Co., and prior to that was with the Mc Culloch Motors Corp. in Los Angeles.

WILLIAM J. SKELLEY, design draftsman for Bell Aircraft Corp., has been transferred from Bell's headquarters in Buffalo, N. Y., to Fort Worth, Texas.

ARTHUR M. STERREN has joined GMC Saginaw Steering Gear Division as senior project engineer. He was formerly with Pioneer Engine and Mfg. Co. in Detroit.

Obituary

PIERRE V. C. SEE

Pierre V. C. See, superintendent of equipment of the Cincinnati Street Railway Co., died on May 24 at the age of 72. He had been ill for a month.

See had been in charge of maintenance of all the Cincinnati Street Railway's vehicles since 1946. Prior to that he served with the Office of Defense Transportation in San Francisco.

A native of New Brunswick, N. J. See graduated from Armour Institute of Technology and entered the transportation field as a car building inspector with the Chicago Elevated Railway. His career included maintenance supervisory posts with Twin City Rapid Transit Co., Illinois Traction System, the Hudson and Manhattan Railroad, Akron Transportation Co. and the San Diego Electric Railway.

See was a member of the American Transit Association, the Central Electric Railway Association and the Engineering Society of Cincinnati and had been an SAE member since 1925.

He is survived by his wife.

TECHNICAL COMMITTEE

Progress

Div. XXVI Set Up as Clearinghouse For Information on Shell Molding

SAE has organized a new fact-finding group to develop information on shell molding useful to castings users.

The new group is Division XXVI—Shell Molding of the SAE Iron and Steel Technical Committee. Division chairman is Charles O. Burgess, technical director of the Gray Iron Founders' Society.

Shell molds are made by bringing a dry mixture of sand and a resinous bonding agent into contact with a hot pattern to form a "shell" good for one-time use. The automotive industry has probably developed the process further than any other group of users, according to information given the Division. However, patent uncertainties have inhibited free discussion. The Division intends to collect and disseminate what data are available on the process. But, of course, it will function in accordance with Technical Board rules, which say "The Board and its committees will not investigate or consider patents which may apply to the subject matter. Prospective users of the report are responsible for protecting themselves against liability for infringement of patents."

Examples of the information on shell

molding exchanged at the Division's first meeting, June 3, are:

- **Accuracy at a Price**—Shell molding is a process midway between low-cost, relatively rough sand casting and expensive, precise investment casting. Each of the three has its place.

- **Better Finish and Closer Tolerances**—Shell molds are sometimes more economic than green-sand molds when total cost of finished parts is compared. Reason is that shell-mold castings have better finish and can be held to closer tolerances. These two factors reduce machining. Some tractor manufacturers are considering replacing machined gears with as-cast gears from shell molds.

Shell moldings is not necessarily the best answer in every case where present sand-casting practice is too inaccurate, however. Required accuracy can often be obtained at less cost by improving existing sand-molding equipment than by switching to shell molding.

- **Less Scrap**—Because shell molds are more permeable and entrap less gas in the casting, there is less scrap. For example, welding tips cast

in green sand incurred 30% scrap in the foundry and 10% more in machining. Now with shell molds, there is less than 1% scrap in the foundry—and no machining is required.

- **Adaptability to Intricate Shapes**—In some cases, substantial savings in machining accrue when parts are redesigned to take full advantage of shell molding. More intricate parts can be cast because more intricate molds can be formed.

- **Materials Savings**—The above advantages of shell molds make them especially useful for casting scarce or costly metals. Switching to shell molds for one particular complicated small casting made it possible to cast to finished shape. Material requirement was cut from 1.6 lb to 1.3 lb per piece. Since the material cost \$1.80 per lb, considerable savings resulted in materials cost as well as in machining cost.

- **Suitability to All Casting Metals**—Shell molds work well with all the usual casting metals from lead through high-temperature steels and even monel. Gating and sprue size vary with the metal to be cast, said Noah Kahn of the New York Naval Shipyard, but the Shipyards' Materials Lab has used the same mold mix successfully for the whole range of cast metals.

- **Low Resistance to Flow**—Shell molds offer less resistance to the flow of molten metal, so metals can be poured at lower temperatures. But the lower the pouring temperature, the less the resin is burned out and the harder it is to shake out the casting.

Chairman Burgess hopes that people with shell-molding experience will feel free to offer their information to Division XXVI. Meanwhile, Division members are critically surveying published literature on the subject in the light of existing practice. When enough information is collected, they will publish a report, and the Division plans eventually to prepare a recommended practice or standard for inclusion in SAE Handbook.

Present at the first meeting of Division XXVI were Chairman Burgess, V. A. Crosby of Climax Molybdenum, Thomas Curry of the Lynchburg Foundry, R. P. Dunphy of the U. S. Navy, Noah Kahn of the New York Naval Shipyard representing H. N. Ames, J. H. Lansing of the Malleable Iron Founders' Society, Vaughn Reid of City Pattern Foundry and Machine Co., E. H. Stilwill of Chrysler, and Fred C. Young of Ford. Acceptances of membership have been received also from H. N. Bogart of Ford, H. L. Day of Auto Specialties, V. P. Gorgutz of Curtiss-Wright, W. E. Jominy of Chrysler, C. F. Joseph of Central Foundry Division of GMC, John Lucas of Fabri-Cast, J. J. Manganello of Chrysler, G. P. Phillips of International Harvester, R. H. Schaefer of American Brake Shoe, and R. F. Thomson of GM Research.

1952 SAE Technical Board

G. A. Delaney, Chairman

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Wrench Clearance Tabulation Developed

A TABULATION of the clearance requirements of wrenches for hexagonal bolts and nuts has been prepared by the Aircraft Drafting Manual Committee S-1. It is planned to include this material in the Aeronautical Drafting Manual. It is now being coordinated with the SAE Technical Board.

Box wrenches, socket wrenches, and normal-duty open-end wrenches, for hexagonal sizes from 0.156 to 1.625, inclusive, are all covered. The values listed are suitable for the majority of wrenches of the types covered that are available to the industry.

The tabulation is important because when bolts or nuts are used for assembly purposes it is essential that sufficient space be provided to ensure adequate clearance for the wrench head and also the wrench movement required for torquing the fastener. When this clearance is applied to flanges, recessed pockets, and the like, an excessive allowance could frequently result in an unnecessary increase in unit weight and a wastage of material.

In preparing this tabulation, the committee was confronted with the nonuniformity of design existing in the wrench industry. The highly competitive market for wrenches necessitates the utmost economy in wrench manufacture that is compatible with wrench quality. Forging and trimming dies are the major contributing factors to the cost of the wrench.

To keep the number of dies to a minimum, it is common practice among individual wrench manufacturers to provide a composite forging for selected sizes of the open-end wrench. The desired slot size is obtained by milling or broaching the forging, leaving the head profile con-

stant, as obtained from the forging die, for all the selected sizes. It is obvious, then, that the head profile of wrenches varies with different manufacturers, depending on the design and manufacturing economies inherent in their individual organizations.

In the early stages of developing the wrench clearance tabulation, committee S-1 contacted a representative group of wrench manufacturers to obtain dimensional data. The results obtained showed wide variations in the dimensions of the various manufacturers.

Subsequently, the Service Tools Institute forwarded copies of specifications MIL-W-15838 (Bureau of Ships) for socket wrenches and MIL-W-15751 (Bureau of Ships) for open-end and box wrenches, that it had been instrumental in preparing for the military services.

Review of these specifications indicated that they compared favorably with the data previously submitted by the various wrench manufacturers, and they were adopted for the preparation of the clearance tabulation for the socket and box wrenches. The specification as applied to the open-end wrench listed, however, only the maximum width and thickness of the wrench head as referenced to the slot opening.

W. B. Billingham of Hamilton Standard Propellers is chairman in charge of this project.



W. B. Billingham, Hamilton Standard Propellers, chairman of the wrench clearance tabulation project of the Aircraft Drafting Manual Committee S-1

Browall Named To Technical Board



HAROLD W. BROWALL has accepted appointment to the SAE Technical Board for a term extending to the end of the 1954 administrative year. SAE President Dr. Daniel P. Barnard designated Browall for the post.

Browall is with the Inland Steel Co. He has long been active on the SAE Iron and Steel Technical Committee. For several years he has been chairman of its Panel A—Steel Producers and a member of its Executive Committee.

Weigh New System for Selecting Crankcase Oils

A NEW system for recommending crankcase oils—based on the type of service in which they'll be used—is before the SAE Fuels & Lubricants Technical Committee. Proposed by API, it's suggested as a replacement for the current API definitions of crankcase oil types (Regular, Premium, and Heavy-Duty) in the 1952 SAE Handbook.

This system developed from action started in the ASTM last year by automotive manufacturers who considered the current system obsolete in view of recent developments in crankcase oils.

It's based on recognition of the fact that lubrication requirements of internal combustion engines are dictated by design and construction, fuel character, maintenance conditions, and operating or service conditions. It further recognizes that service conditions can vary over a wide range and have a major influence upon the type of

oil required by individual designs. Thus, the system is based on definitions and explanations of various service conditions encountered in operation of gasoline and diesel engines.

The various services designated by code letters are ML, MM, MS, DG, and DS. It's believed that the present "Regular" oils would correspond to the oils for use under ML service conditions. "Premium" oils for use under MM service conditions, and the present "Heavy-Duty" oils would be divided into three groups:

1. Present 2-104B, MIL-0-2104, and Supplemental List 1 oils would all fall into the group of oils that would be recommended for use under MS service conditions.

2. Present MIL-0-2104 and Supplemental List 1 oils would fall into the group of oils recommended for use under DG service conditions.

3. Present Supplemental List 2 oils would fall into the group of oils recommended for use under DS service conditions.

Right now F&L Subcommittee B is eyeing this new system from the automotive point of view. The subcommittee plans to revise the explanatory material accompanying each service classification to reflect this viewpoint; then submit the resulting proposal to the main F&L Committee at the Tulsa F&L Meeting.

SAE Considers Standardizing Components for 12-V Systems

THE TREND toward 12-v electrical systems in future passenger cars poses some new projects for SAE technical committees.

Interest in 12-v systems stems from proposed higher compression ratios. The higher the compression ratio, the higher the pressure in the cylinder at firing and the greater the voltage needed to bridge the spark plug gap. To achieve the required higher voltages in the secondary circuit of the ignition coil and still have satisfactory performance of the breaker mechanism, higher primary voltages are needed, say the 12-v advocates.

In capacities suitable for passenger cars, the present SAE Standard on Storage Batteries covers only 6-v batteries. So the Battery Subcommittee of the Electrical Equipment Committee is looking into possibilities of preparing specifications for envelope dimensions and performance requirements of 12-v batteries.

At its session during SAE Summer Meeting, the Battery Subcommittee decided to invite engineers from battery and car factories to submit their ideas on envelope dimensions, capacities, test procedures and nomenclature.

A shift to 12-v systems will require design changes in starter motors and

generators, circuit breakers, cigar lighters, flashers for signal lamps, radios, and accessories incorporating electric motors.

The SAE Electrical Equipment Committee at its session during Summer Meeting agreed that starter motors and generators for 12-v systems are a function of car design and are not yet ripe for standardization. But the Committee approved initiation of standardization work on circuit breakers and cigar lighters for 12-v systems. P. C. Kent, new chairman of the Electrical Equipment Committee and a member of the SAE Lighting Committee, noted that the Lighting Committee is considering undertaking standardization of flashers for 12-v systems.

Gaging Standards For Involute Splines

IN the six years that standards for involute splines and serrations have been available, manufacturers have been requesting data on gaging. Now

a proposed SAE Standard has been developed that provides this information. It covers different types of fits and several systems of gaging to meet the demands of various industries.

Supplements Old Standard

The new proposal, "Involute Spline and Serration Gages and Gaging," and the earlier standards (1952 SAE Handbook, pp. 521-604) thus supplement each other and provide a complete picture as far as the design and manufacture of involute splines and serrations are concerned.

The proposed standard was developed by the Spline Gaging Subcommittee of the SAE Parts & Fittings Committee. (Chairman of the subcommittee is G. L. McCain, of Chrysler.) The subcommittee worked with a subcommittee of the Sectional Committee B5 of the American Standards Association, which is also considering this proposal for approval as an American Standard. (At the time the SAE standard was first published the ASA also issued standards that were comparable in every way with the SAE standards. These are American Standards B5.15-1950, "Involute Splines," and B5.26-1950, "Involute Serrations.")

Sponsors of the ASA Standard are SAE, the Metal Cutting Tool Institute, the National Machine Tool Builders' Association, and ASME.

Technishorts . . .

BODY WELDING MANUAL—Do's and don'ts in welding automobile bodies—these are just a few of the handy tips being compiled for a new body welding design manual. Other useful information slated for this joint SAE-American Welding Society project are sections on welding materials, processes, basic considerations, and body design. SAE participants appointed by the SAE Body Engineering Committee to serve on the manual author committee are H. V. Atnip, W. Bright, Jack Ogden, and C. E. Wittmer.

HYDRODYNAMIC DRIVE RECOMMENDATIONS—Three new SAE Recommended Practices relating to hydrodynamic drives have just been approved by the SAE Technical Board. They are:

- Symbols for Hydrodynamic Drives, for use in technical papers and engineering reports.
- Performance Charts for Hydrodynamic Drive Vehicles, five forms for recording vehicle performance data.
- Color Code for Hydrodynamic Drive Illustrations, for diagrams of drives and their installations.

All three were prepared by the SAE Hydrodynamic Drive Committee.

MAGNETIC PARTICLE INSPECTION—Fundamentals of the process are outlined in the recently approved SAE General Information Report on Magnetic Particle Inspection. The report was drawn up by Subcommittee VI of Division XXV of the SAE Iron and Steel Technical Committee.

Vehicle Nomenclature Up for Committee Review

AT the request of the AMA, the SAE Commercial Vehicle Nomenclature Committee has been reactivated. Asked to review the SAE Standard on Commercial Vehicle Nomenclature, the committee set the wheels in motion at its Summer Meeting reorganization confab.

Five subcommittees were set up to study various sections in the present standard. Each will take a part in the committee's overall plan—first to define vehicle, second motor vehicle and all its variants, then commercial vehicle as distinguished from private, emergency, and other motor vehicles, and finally all types of commercial vehicles. The committee also feels that the standard should have an introductory paragraph or two . . . so this, too, has been put on the agenda.

Next meeting is scheduled at the T&M Meeting in Pittsburgh, where committee chairman F. K. Glynn, of American Telephone & Telegraph, will again take up the gavel.

Stage 'Copter Rescue From Raft in Pearl Harbor

• Hawaii Section

F. C. Leensvaart, Field Editor

April 21—"That's like threading a needle with boxing gloves on," exclaimed one fascinated spectator . . . "Man! That's really something!" agreed another. The object of their attention was a man swaying precariously on the end of a quarter-inch cable, with the waters of Pearl Harbor five feet beneath him, the whirling rotor of a helicopter some fifty feet above him. He had just been picked up from a rubber life raft, and was slowly being hauled into the pilot's compartment of the 'copter as part of a demonstration staged by 11th Air Rescue Squadron at Hickam Air Force Base for the Hawaii Section of SAE.

From the deck of the swimming pool adjacent to the Hickam officers' mess, from which they had watched the helicopter show, the engineers were taken to 11th Rescue hangars on the flight line. By the time they arrived, Maj. C. G. Brosnan, who had effected the simulated rescue in the Harbor, had landed his Sikorsky H-5D helicopter and was ready with a detailed explanation of how it was done.

Next major item of interest was a familiar looking yellow boat, which the visitors had seen many times on the underside of SB-17's flying search and rescue missions over Hawaii, but had never inspected at close range. A thorough briefing on the drop mechanism and the infinite amount of survival equipment in the sturdy, 27-foot craft was given the visitors by Lt. L. R. Tinto.

Following a graphic exhibition of electronic and radar facilities by both

SAE Section Meetings

A and B flights of the squadron, guests were returned to Hickam officers' mess for a summary of the mission and activities of Air Rescue Service by Lt. Col. Walter E. Thorne, commanding officer of the 11th, plus a 30-minute movie depicting an actual helicopter rescue mission.

By the time the tour ended at ten-thirty, it was a safe bet that all future helicopters and boat-equipped SB-17's flying overhead would evoke more than casual interest in the eyes of Honolulu members.

at the final meeting of the Mid-Michigan Section, which included golf and dinner at the Owosso Country Club.

Showing a number of slides to illustrate both vacuum and electric windshield wiper installations, Webb pointed out that a comparison of the two types of wipers should not be made without considering the vacuum pump as a part of the vacuum wiper installation. In fact, some state legislatures have adopted laws requiring such equipment, while others are considering similar moves. This makes it seem that the automotive industry is placed in the position of waiting for the government to force the manufacturers to adopt certain improvements. It probably would be better for all concerned to have the industry take the lead and thus make any legislation unnecessary.

There have been other means of operating power windshield wipers, but the only two commercially acceptable systems which have survived are the vacuum and electric drives. The other possible schemes, such as a direct mechanical drive or a hydraulic drive, have the disadvantage that they would consume power all the time even when the wiper was not in use. At the present stage of development, the elec-

Tells of Developments In Automotive Accessories

• Mid-Michigan Section

Robert King Hirchert, Field Editor

May 13th—Neither electric nor vacuum windshield wipers now being used have sufficient power to work satisfactorily on curved windshields according to Edmond F. Webb of Webb Engineering Associates, who presented a paper on "Automotive Accessories"



Hickam Air Force Base was the scene of the April 21 meeting of Hawaii Section, where members witnessed demonstrations by the 11th Air Rescue Squadron. At left, Lt. L. R. Tinto briefs the group on the survival equipment of the boat carried on flying search and rescue missions. At right, Maj. C. G. Brosnan (right), who made a dramatic demonstration rescue from the waters of Pearl Harbor, explains the workings of his Sikorsky H-5D helicopter to Bob Muller (left) and Harry Smythe.

tric wiper is still more costly than the combined vacuum wiper and vacuum pump installation; but there is considerable evidence that this situation may be reversed in the near future due to the necessity of designing units with more power in order to work satisfactorily with the increased blade pressures necessary to maintain blade contact on curved windshields at high speeds. Of course, both vacuum and electric wipers can be designed to give more power, but this apparently offers a greater problem in connection with the vacuum design than with the electric design. More powerful vacuum units would tend to become extremely large and considerably more expensive, while a corresponding increase in power in an electric design could be obtained more economically.

While almost all original equipment windshield wiper blades are very satisfactory, it is unfortunately true that many of the replacement blades being sold are definitely inferior in their wiping ability. There are two wiping edges on each blade, each of which operates in only one direction. The secret of manufacturing a good wiping blade is to have both edges true and sharp. Unfortunately, this sharp edge is subject to relatively rapid wear in service; to maintain the maximum efficiency of the windshield wiper blade, replacement after some twenty hours of use is desirable. Of course, most car owners do not change their blades this frequently, if at all, and they are entirely satisfied with their windshield wiping operation. Actually, the critical period when the sharpness of the blade edge is important only lasts for a short time when the rain is starting. As soon as the glass is thoroughly wetted, even an old worn blade

does a reasonably satisfactory job.

In the past eight years windshield washer sales have risen from almost nothing to amazing proportions—due more to customer's recognition of their desirability than to sales pressure. There are two types now being produced: the vacuum unit which was first in the field and the more recent innovation which is powered by a foot-operated pump. Of course, the operation of the vacuum type suffers if a vacuum pump is not provided, but even under the best conditions the foot-operated pump will deliver more pressure. Since most automatic transmissions have eliminated the clutch pedal there seems no reason why the left foot should not be utilized to operate the windshield washer.

Fuel filters located at the gasoline tank outlet pipe are now being given more consideration. There are several satisfactory types which use an element material which will pass gasoline but is not easily wetted by water. One type in particular, which has a Saran plastic filter, is designed so that as the tank becomes empty the fuel pump begins to draw in a mixture of air and fuel which noticeably reduces engine power but permits a few miles of operation after the first symptoms appear.

Mr. Webb admitted that most automotive clocks are not as reliable as could be desired but pointed out that the problem is very difficult to solve due to the wide variety of adverse conditions under which they are expected to operate. Even the most costly wristwatch is not capable of running under the extremes of cold and heat which the automotive clock must endure.

The discussion period which fol-

lowed included some comments on the new electronic eye device introduced this year by Cadillac and Oldsmobile for automatically depressing the headlights, and it was brought out that the extreme sensitivity on the experimental models has been overcome in the production units.

The problem of the freezing up of the flexible action of the curved windshield wiper blades was discussed and it was noted that at least one of the manufacturers is working on a plastic boot to eliminate this difficulty.

Supersonic Craft Not Easy to Build

• Southern California Section

B. W. Clemens

April 29—Design features of supersonic aircraft present new and knotty problems in tooling and manufacturing departments of airframe builders, a six-man panel agreed.

The six were A. C. Wallen, tooling manager of Douglas Aircraft's Long Beach Division; R. B. Smith, assistant chief aerodynamicist of Douglas Aircraft's El Segundo Division; Reed Scot, supervisor of manufacturing research for Lockheed; L. G. Vines, supervisor of tooling and manufacturing planning at Douglas' El Segundo Division; R. L. Pollack, tooling superintendent for North American Aviation; and B. W. Clemens, chief tool project engineer of Douglas' Long Beach Division.

The five major problems as they saw them are:

1. Wings and fuselages are becoming thinner and thinner. At the same time, more equipment must be crammed into them. This makes it wise to design assemblies in units on which installation work can be done prior to joining operations.

2. The new wing structures dictated by aerodynamic considerations call for large, heavy skins. The problem is to increase capacity to forge and machine these oversize members.

3. New materials or heavier gages are needed to withstand the high temperatures generated by adiabatic heating at flight speeds. One of the new metals, titanium, requires special machining and forming techniques. Heavier gages, too, bring their own machining problems.

4. For supersonic flight, wing leading edges are considerably smaller in radius, yet the same close tolerances must be maintained.

5. In many cases, the tooling engineer does not know when he is designing the tooling whether few or many planes of a given model will be built. This complicates the problem of deciding how much labor-saving tooling is worth while.



A day of golf at Owosso Country Club preceded the May 13 meeting of Mid-Michigan Section, at which Edmond F. Webb described developments in automotive accessories. Standing, left to right: Charles Bachrich of Delman Industries; Norman Servies, Redmond Co.; Lee Clark of Webb Engineering Associates; speaker Edmond F. Webb, Webb Engineering Associates; and Les Smith of Redmond Co. Kneeling are Julius Fisher of Redmond and Buster Lane of Plymouth Division.

Massey-Harris Plant Host to Milwaukee Section



Members of Milwaukee Section who visited the Massey-Harris plant in Racine, Wis., on May 2 were greeted by M-H President H. H. Bloom at a noon luncheon . . . Before touring the plant, guests saw models of Massey-Harris products on miniature farms



Guests watched dynamometer testing of tractor output; also saw tractor assembly lines, forging shop, laboratories, and a dust room in which tractors undergo the equivalent of severe field wear . . . Later heard Einar Dahl speak on dust room testing

- Milwaukee Section
George A. Rea

May 2—More than 200 members of Milwaukee Section visited the Massey-Harris plant at Racine, Wis. The trip was divided into three major parts—an excellent buffet luncheon at the Massey-Harris plant at noon, the tour of the plant in the afternoon, and adjournment for dinner and a paper by **Einar Dahl**, Massey-Harris experimental engineer, in the evening.

H. H. Bloom, Massey-Harris president, welcomed the group at the noon luncheon and gave an explanation of what would be seen on the plant trip.

The plant tour lasted approximately three hours and covered the main points of interest in the Massey-Harris plant, including the tractor assembly line, the machine shops, forging shop, and also the Massey-Harris experimental laboratory, including observing the dynamometers in operation and the dust room in which a tractor was

undergoing actual testing. The dust room, in which abrasive dusts duplicating severe field conditions were showered on a tractor, was especially interesting since the members knew that the paper which was to be given later that evening would cover the dust room testing which Massey-Harris has perfected.

After dinner the regular monthly meeting of the Milwaukee Section was held, and Einar Dahl presented his paper on "Dust Room Testing."

Arthur Eck Wins Mac Short Award



At the May 8 meeting of Southern California Section the annual Mac Short Memorial Award was presented to Arthur Eck, aeronautical engineering student at Northrop Aeronautical Institute.

At left, the award is presented to Eck by Mary Short, daughter of the late Lockheed executive and SAE past president, while Southern California Section Chairman B. T. Anderson watches. Eck, a veteran, will graduate from NAI in August.

Below, Miss Short presents scrolls to six runners-up. They are (left to right): D. E. Benkert, represented by R. K. Mallis, University of Southern California; G. R. Bennett, Cal-Aero Technical Institute; R. E. Fraia, California State Polytechnic College; Arthur Eck; D. W. Wagner, California Institute of Technology; E. T. Sullivan, Loyola University; and D. R. Clarke, West Coast University.



Says Delta Wings Superior for Speed

• Southern California Section
P. Kyropoulos

May 8—At the May meeting the annual Mac Short Memorial Award for the outstanding SAE student member of the year was made. The recipient was Arthur Eck, Northrop Aeronautical Institute. The award was made by Miss Mary Short, and Mrs. Mac Short was guest of honor. Six other competing student members were given scrolls.

Speaker of the evening was K. E.

Van Every, chief aerodynamicist, El Segundo Division, Douglas Aircraft Co., who spoke on the subject "An Engineering Comparison Using Straight, Swept and Delta Wings."

In an attempt to find the answers to some of the controversial questions on the relative merits of straight, swept, and delta wings for use on high-speed airplanes, a study of three typical configurations designed to meet the same requirements has been made. It is concluded that the swept-wing and delta-wing airplanes have superior high-speed performance. If the airplane is to fly subsonically only, the delta-wing configuration usually has the higher critical Mach number and

therefore the higher cruising speed. Also the requirements of supersonic flight are more easily met by the delta-wing configuration, because of its lower peak drag for a given gross weight.

With regard to handling characteristics, it is generally possible to make a relatively simple control system for the conventional straight-wing or swept-wing airplane, which employs a horizontal tail. The delta-wing configuration invariably requires the use of the more complex power controls.

Traces Development Of Mack 4-Cycle Diesel

• New England Section
George T. Brown, Field Editor

May 10—Every engineering decision is a choice of advantages and necessary disadvantages, Merrill C. Horine of Mack Motor Truck Corp. told New England Section members. Each decision involves others, because the adoption of one feature almost always requires the sacrifice of others.

Horine outlined this engineering philosophy by tracing the development of the Mack four-cycle diesel engine. Actually, the choice of four-stroke or two-stroke cycle was of little importance in itself, he said; the choice of a four-stroke engine was the means to certain ends.

Chief functional contrast between the two types of engine is in the manner in which intake and exhaust are accomplished, Horine declared. In the four-stroke cycle, air is drawn in by the evacuation of the cylinder by a downstroke of the piston, and the spent gases are ejected on the upstroke of the piston. In the two-stroke type, most of the piston travel in the two strokes is consumed in compression and expansion, so that exhaust and intake must be effected within a limited period at the bottom of the piston stroke.

The question period brought out that two- and four-cycle diesel engines can develop about the same speed range of around 2400 rpm; that diesel engine fuel consumption is about 60 to 75% better than that of gasoline engines, which tends to offset the initial high cost of diesel equipment; and that there is no conflict created by the difference in weight between the diesel and gas engine in heavy duty trucking equipment, since such weight is placed over the front axle and does not interfere with the payload. A high percentage of road failures are attributed to ignition troubles, which are nonexistent in diesel engines.

Barnard Addresses Northern Californians

• Northern California Section
J. C. Ellis, Field Editor

May 15—The Claremont Hotel in Berkeley was the scene of the "Presidents' Meeting" of the Northern California Section for the 1951-52 season. Over 100 guests and members enjoyed a social hour with the Society's President, **Dr. D. P. Barnard**, on the sun deck overlooking San Francisco Bay. Dinner and meeting followed in the Salem Room.

At the conclusion of the business session Jack MacGregor of California Research Corporation introduced Dr. Barnard who spoke on the subject "Research—A Partner in Engineering". Tracing the history of the petroleum and automotive industries, Dr. Barnard emphasized that the present status of technical development had been reached in less than 100 years. Pointing out that gasoline initially was an unwanted by-product in the manufacture of kerosene, he stated that it was not until 1910 that the demand for gasoline exceeded the supply, and even during World War I the total production of all gasolines amounted to only some 20% of the crude processed and that this gasoline averaged only 50 Research Method octane numbers.

New Processes

The increase in crude availability through advances in exploration techniques was accompanied by improvements in manufacturing methods, all of which resulted in both increased quantity and quality of available fuels. The original Burton process was followed by other thermal cracking methods, and these were displaced or augmented in time by catalytic cracking, polymerization, hydrogenation, alkylation, isomerization and catalytic reforming.

Barnard further indicated that, although Research octane numbers for the average of all gasoline produced had increased from 50 to 84 approximately from the period of World War I to the present, the increase in absolute performance was far less with performance numbers increasing from approximately 36 to 64. Thus, although a 34 octane number increase in this period has brought average gasoline within 16 octane numbers of iso-octane, a 28 performance number increase is still 36 numbers away from iso-octane. The production of additional octane numbers in this region is difficult and costly, he stated, with octane numbers at the 100 level four times more expensive to manufacture than at the 65 level.

Dr. Barnard concluded by saying that the rapid advances in automotive and petroleum engineering have been due to the research effort expended by

these industries through large staffs of technically trained personnel. He believes, however, that a shortage of these people now exists and that until 1960 two or three times as many engineers will be needed as are available.

Describes and Compares Supercharger Performance

• Northern California Section
J. C. Ellis, Field Editor

April 23—The Diesel Engine Activity of Northern California Section scored again when Warren Brown, diesel chairman, introduced **Dr. W. T. von der Nuell**, world authority on turbine machinery, to one of the largest, and certainly the most diversely repre-

sentative engineering gatherings of the year. An additional feature was the sketch given by **C. G. A. Rosen** on personal observations abroad of the work and scientific influence of the evening's speaker.

Dr. von der Nuell spoke in a clear style spiced with wry humor on the complex subject of "Superchargers and their Comparative Performance". Exhaust-driven superchargers now can be fitted to engine requirements with such exactness that performance over the entire operating range of 4-stroke and 2-stroke otto and diesel engines can be made to conform to the desired pattern of the design, he told the group.

Reminiscing, Dr. von der Nuell described the conception of the closed compressor rotor and the rebuffs attendant to its proposal, the "insane notion" that a right angle or radial



SAE President D. P. Barnard (left) talks to Jack MacGregor of California Research Corp. on the sun deck of the Claremont Hotel in Berkeley before the May 15 meeting of Northern California Section



At the April 23 meeting of Northern California Section, Dr. W. T. von der Nuell told of developments in superchargers and made comparisons of their performance. Left to right: Section Chairman W. G. Nostrand, Dr. von der Nuell, and W. G. Brown, who was technical chairman of the meeting



At the May 19 meeting of Salt Lake Group, newly-elected Chairman Dean Despain presents certificate to retiring Chairman Stanley W. Stephens. Left to right: Dean Despain; Clark E. Smith, past chairman of Salt Lake Group; Richard Ostlund, newly-elected vice-chairman; and Stanley W. Stephens.

turbine was practicable, and pioneer work on low cost turbo compressors for small gasoline engines.

He stressed the fitting of the turbine compressor characteristics to the needs of the engine, and showed means by which the required flat characteristics of the turbine machinery were achieved economically. The simplest floating (uncontrolled) combination of exhaust driven turbocharger and engine was contrasted with limited control via an exhaust waste gate and finally with a practicable variable-area turbine nozzle control. In terms of economy and especially safety for automotive use, he pointed out, a combination of proper control plus right-angle turbine layout is nearly ideal; the rotor of the latter is inherently safe, because if overstressed it folds against the casing, thus stopping the machine. Armor plate perhaps would be required to intercept the fusillade of radial blades under similar circumstances.

meeting attendance. The importance of a concentrated effort to increase membership of eligible men of varied industries and of a variety of programs that will hold the interest of all was pointed out. Chairman Stephens emphasized the value and importance of attendance of this summer's West Coast Convention.

The traditional certificate of honor was presented to departing Chairman Stanley W. Stephens, and newly-elected Chairman Dean Despain was installed in office with his fellow officers Richard Ostlund, vice-chairman, and William Bernard Littreal, secretary-treasurer.

Salt Lake Group Winds Up Successful Year

• Salt Lake Group
J. P. Bywater, Field Editor

May 19—A review of the year's activity and a business meeting marked the end of a successful season under the leadership of Chairman Stanley W. Stephens.

A number of nationally prominent speakers enriched meetings, offering members a source of knowledge unsurpassed in the Salt Lake area. Consensus was that a spreading of responsibilities tends to increase interest and

Chicago Chooses Prize Student Paper

• Chicago Section
R. M. Ladovich

April 30—The third annual Chicago Section student meeting was held at Illinois Institute of Technology and featured talks by students and Wally Parks and Don Francisco, editors of **Hot Rod** magazine. Student speakers were Allyn Erickson of Aeronautical University, Joseph Alber of Northwestern, and Ronald Watson of Illinois Institute. Frederick Phleterer, chairman of the SAE student group at Northwestern, was meeting chairman.

Parks and Francisco reviewed the development of hot rodding in the west, where it originated, and went on to describe the competitive and technical aspects of the sport with the aid of sound color films. The high spot

of the year for hot rod enthusiasts is the annual race meet at the Bonneville speed flats, which attracts hundreds of entries in twenty-two classes. In the films, the audience saw a superbly designed and streamlined vehicle setting a record of 230 mph, a Crosley design revised to smaller overall dimensions in which the engine compartment was fitted to receive a V-12 or a GM 6-71 engine, and a number of tear-shaped designs incorporating one of two aircraft drop fuel tanks, as well as a host of other advanced designs.

The three student speakers for the evening were winners of competitions in their respective universities. Members of the Chicago Section governing board chose Ronald Watson of Illinois Institute, who spoke on "Why Not Build a Better Two-Cycle Gasoline Engine," as winner of the Chicago Section student trophy. Allyn Erickson's paper on "Design of an Airplane" and Joseph Alber's on "A New Casting Method for the Automotive Industry" were close runners-up.

The meeting was attended by more than 225 members, students and guests, many from local hot rod and sports car clubs.

Traces 'Copter Back to Marco Polo

• Texas Section

A. P. Johnston, Field Editor

May 9—Members of Texas Section heard Hans Weichsel of the Bell Aircraft Corp. present a talk on the modern helicopter. Weichsel introduced the modern helicopter by a brief review of the basic history going back as far as Marco Polo's contact with flying tops in the Far East. Since the late 1920's, considerable experiments with autogyros, flying models and full scale experimental helicopters have been initiated, resulting in the modern helicopter.

Bell has been actively engaged in the development and manufacture of helicopters since 1942 and has recently opened the new Fort Worth plant for the exclusive production of helicopters. Many of the Bell helicopters have seen varied action in Korea and have created an ever increasing demand for additional machines. For instance, one small helicopter can evacuate as many wounded as approximately 10 ambulances; and commanding officers are allowed as much front line combat contact in one hour of helicopter travel as formerly required days. The helicopter is used for many other tasks in combat, such as liaison, observation and supply.

The Korean war has been a proving ground for the helicopter and has provided it with a reputation sufficient to

make it acceptable to the general public for commercial application, such as air mail and air passenger feeder line service. Within five years and probably less, Weichsel expects airport commuter helicopter service to be as familiar as the present day airport limousine and at comparable costs.

The helicopter is basically a very safe flying machine. Rotor blades have an infinite life and have sufficient kinetic energy to allow easy landing following autorotation. Autorotation is a method of landing the helicopter without power.

Two films substantiated the versatility of the helicopter. "Mercy has Rotary Wings" depicted actual scenes of the Bell helicopter in ambulance service in Korea. "Utility Unlimited" presented the civilian version of the helicopter participating in many of its versatile jobs.

Says New Vehicles Are Maintenance Problem

• Western Michigan Section
Tom Reeves, Field Editor

May 20—Field maintenance problems were highlighted at the May meeting of Western Michigan Section. Principal speaker was **Robert J. Ruppe**, general superintendent of shops and equipment, Chicago Transit Authority. Questions were handled by the speaker and a panel composed of **Karl Kutz**, Greyhound; **A. E. Morrison**, Ralph Stark Co., Inc.; and **Lyle Stringham**, Continental Motors Corporation.

A strike at factory quality and design was taken by the speaker when he stated that main items of maintenance involved new vehicles. Largest number of hours in Chicago transit were spent in improvements or repairs on new vehicles to make them satisfactory for road performance and endurance.

The second maintenance item in size involved body damage, which Ruppe blamed on inadequate facilities to handle bus size.

Continuing, the speaker emphasized the value of statistical control. Proper inspection at right time can result in complete elimination of road failure of major parts. (Chicago has not had a broken crank in two years.) Major parts are completely torn down, inspected and sent out to be rebuilt. Parts are usually rebuilt up to a cost of 60% of a new item. Life equal to that of a new part is expected.

Despite rising costs, Chicago has managed to hold maintenance cost to \$.06/mile. This has been accomplished by design and use of equipment and jigs to increase shop efficiency. Shop cleanliness is an important additional item to maintain a high working efficiency.

Salt Lake Members Tour Hill Air Force Base

• Salt Lake Group
J. P. Bywater, Field Editor

April 25—Members of Salt Lake Group were guests of Hill Air Force Base. The group dined at the officers' club, and then were taken on a two-and-a-half hour tour of the station's facilities.

The tour, aimed at the special interest of engine experts, was concentrated on Hill's Maintenance Engineering Division. The visitors saw a block-long assembly line where scores of Pratt and Whitney R-2800 aircraft engines are being rebuilt. They also inspected the engine test section where the plane engines are mounted in huge concrete revetments and "run up" for six hours to test performance before being mounted on an aircraft.

The group was conducted through various operating sections of the air station. They visited Base Flight Operations, heard lectures on the air weather service, aircraft dispatch procedures, and were given a close-up look at some of the nation's largest cargo planes, and the F-86 "Sabre-Jet" of Korean fame.

Brigadier General A. H. Gilkeson, commanding officer at Hill Air Force Base, expressed his pleasure at having the engineers as visitors through a representative of the Special Projects office.

See New Facilities At Aeroproduccts Division

• Dayton Section
W. D. Hazlett, Field Editor

May 22—A trip through the plant of GMC Aeroproduccts Division wound up the 1951-52 meeting schedule of Dayton Section. The group was greeted by Factory Manager R. E. Gould, who reviewed the history of the plant and the 12-year-old division of General Motors, and discussed recently completed additions to the plant.

Technical talks and movies about the propellers and actuators produced at the plant were presented by R. C. Treseder, assistant chief engineer in charge of design, and R. R. LaMotte, chief engineer. Actuators are of both the hydraulic and electro-mechanical types, and are used for landing gear, bomb bay doors, canopies, flaps and so forth. Aeroproduccts is currently making propellers for the C-119, the A-2D, the A-4D and the T-28 airplanes. Blades consist of a forged thrust member and a camber sheet approximately .001 in. thick. The camber sheet is braised to the thrust member to form the complete blade. Aeroproduccts uses unique methods in fabricating the propellers.

Ladies Take Over Group's Final Meeting

• Mohawk-Hudson Group
Krud Antonson, Field Editor

May 23—The May meeting of the Mohawk-Hudson Group was held at the Locomotive Club in Schenectady. The last scheduled meeting of the season was devoted to the ladies.

After a sound color movie, "Our American Crossroads," Armand DeCarlo's orchestra provided music for dancing. During intermissions the many members and their guests enjoyed barbershop quartet singing by "The Mohicans." A buffet supper was served.

This was the first time the Mohawk-Hudson Group closed the season with a Ladies' Night. Judging by the large gathering and the opinions expressed, the party was such a success that in the future Ladies' Night will be a permanent annual attraction on the group's meeting schedule.

The party was preceded by a short business meeting, at which officers for the coming year were announced.

Martin Berlyn, chairman of the group for the 1951-52 season, was presented with a past-chairman's certificate by C. W. Wyld, vice-chairman.



At the May 22 tour of Aeroproduccts Division of GMC, Dayton Section members watched production of propellers and actuators. Examining a part are D. D. Bowe (left), chief aerodynamicist at Aeroproduccts and past chairman of Dayton Section, and current Chairman C. I. Lathrem.

SAE National West Coast

August 11-13, Fairmont Hotel, San Francisco

Monday, August 11

9:50 a. m.

SAE Northern California Section
Welcomes SAE

W. G. NOSTRAND, Section Chairman
Acknowledgment by
SAE President **D. P. BARNARD**

10:00 a. m.

Chairman, **H. E. LOVEJOY**, Puget Sound Freight Lines
Secretary, **B. E. BOSWELL**, Shell Oil Co.

Finding Horses that Can Be Put to Work

E. L. CLINE, Clayton Mfg. Co.
Practical proved methods for taking full advantage of service chassis dynamometer equipment are dealt with practically in this paper. Prepared discussions by authorities in their fields will supplement the paper itself.

Prepared discussion by

A. S. SPRINGER, Pacific Intermountain Express
A. S. LEONARD, Cummins Engine Co.

What Makes Maintenance Click

D. H. MIKKELSON, Los Angeles-Seattle Motor Express
General fleet maintenance can be bettered by proper attention to its major elements, such as shop area, tools and equipment; service facilities; personnel; costs records; efficient purchasing. This paper tells how to do it.

Sponsored by Transportation and Maintenance Activity

2:00 p. m.

Chairman, **E. B. OGDEN**, Consolidated Freightways, Inc.
Secretary, **R. A. COIT**, Shell Development Co.

The Humphreys Controlled Compression Engine

(More Miles, More Power, on Pump Gas)

W. H. PAUL, Oregon State College
I. B. HUMPHREYS, Humphreys Investment Co.
A conventional powerplant to which

has been added a device for automatically varying the clearance volume of the combustion chamber. This allows compression ratio to be varied. Paper describes results of this varying in terms of fuel consumption and anti-knock qualities.

Can Engine Wear Be Trapped in a Can?

R. J. POOCK, Ford Motor Co.
Analyzes factors contributing to engine wear and shows how it can be counteracted effectively by using available equipment. Data based on 50 engines and 845,082 miles of operation.

Sponsored by Fuels and Lubricants Activity

Tuesday, August 12

9:30 a. m.

Chairman, **S. W. STEPHENS**, Diesel Electric Service & Supply Co.
Secretary, **P. L. PINOTTI**, California Research Corp.

Using Horsepower for Heavy-Duty Steering

W. F. DRIVER, Vickers, Inc.
Power steering as applied to heavy-duty trucks.

Engines to Digest the Vitamin Enriched Fuel Elpeegee

J. E. GLIDEWELL, Hall-Scott Motor Co.

To use LPG efficiently, engines should be designed to stand higher compression ratios, have cold intake manifolds, hard-faced exhaust valves and seats, dependable carburetion . . . a big load on behind and an open road in front.

Sponsored by Truck and Bus Activity

2:00 p. m.

Chairman, **B. TROUT**, Truck Parts and Equipment Co.
Secretary, **J. V. DeCAMP**, Norton Truck Co., Division Safeway Stores, Inc.

Transmission Bearings for Heavy-Duty Service

E. J. BARTH, Spicer Mfg. Division, Dana Corp.

T. BACKUS, Fuller Mfg. Co.
Paper discusses transmission development, new designs and failures encountered, and relation of bearing failures to life of transmissions.

Deadweight—Static or Dynamic Design?

W. P. DAVIS, Associated Transport, Inc.

Suggests how to reduce tractor and trailer weight without destroying adequate strength, how to provide greater cubic capacity for semi-trailers, and how to improve design in relation to maintenance and safety.

Sponsored by Transportation and Maintenance Activity

6:45 p. m. GOLD BALLROOM

BANQUET
W. G. NOSTRAND
General Chairman of Meeting

J. W. SINCLAIR
Toastmaster
Manager, Automotive Department
Union Oil Co. of California
D. P. BARNARD, SAE President

"INDUSTRIAL ADVANCEMENT UNLIMITED"

ROGER DEAS
American Can Co.

Wednesday, August 13

9:30 a. m.

Chairman, **E. J. ELDENBERG**, Washington Auto Carriage Works
Secretary, **H. M. HIRVO**, Enterprise Engine and Foundry Co.

What's Ahead in Commercial Vehicle Powerplants?

C. G. A. ROSEN, Caterpillar Tractor Co.
Evaluates future place of high-speed diesels, air-cooled and supercharged 4-cycle diesels, 2-cycle diesels . . . and

Meeting

25 Years Ago

Facts and Opinions from SAE Journal

of July, 1927

the gas turbine for West Coast powerplants. Discusses also significance of foreign developments currently being licensed in United States.

Wanted—A Better Engine Intake Air Filter

R. E. BROWN, Air-Maze Corp. The editorial questions, What? How? and Why? of engine intake air filters are asked and answered through a discussion of the various types of air filters now made and used as engine intake air filters and an explanation of the advantages and shortcomings of each type.

Sponsored by Diesel Engine Activity

2:00 p. m.

Chairman, **B. T. ANDERSON**, Union Oil Co. of California
Secretary, **P. I. BROWN**, California Research Corp.

Tailoring Lubricating Oil to Fit Service Requirements

J. A. MILLER, California Research Corp.

B. M. BERRY, Standard Oil Co. of California

Ways to use the new API service designations in selecting lubricating oils for a specific service are demonstrated . . . also, how to tailor lubricating oils to fit these requirements.

Simplifying Grease Lubrication for Automotive Equipment

L. W. McLENNAN, Union Oil Co. of California

DR. EARL AMOTT, Union Oil Co. of California

Studies of lubricating grease use indicate most chassis points are effectively lubricated even when between-lubrication periods are longer than average. Use of multipurpose grease offers service station real advantage—but less than offered to fleet operator, paper says.

Sponsored by Fuels and Lubricants Activity

With this issue, the Journal celebrates its tenth anniversary. Older members will remember that the Society's monthly publication before July, 1917, was the SAE Bulletin.

Camber, toe-in, and steering geometry of the front axle merit more consideration than they have had in the past. Proper attention to these points will contribute another refinement to motor-car design.—J. E. Hale, Firestone Tire and Rubber, in Semi-Annual Meeting paper.

Carbon deposition increases detonation in proportion to the greatest thickness of carbon over any considerable area of the combustion chamber.—Neil MacCoul and D. B. Brooks, Texas Co., in Buffalo Section paper.

Development of ignition equipment specifically adapted to aircraft engines has just begun. A glance at almost any aircraft engine gives a distinct impression that the ignition equipment has been hung on after the engine was finished.—F. G. Shoemaker, Air Corps, McCook Field, in Chicago Section paper.

The most expensive luxury tolerated by the motor-car buyer today is the thoroughly inadequate, inefficient three-speed transmission. This unit materially shortens the life of exceptionally well-built engines and soon ruins their quality of quiet operation.

The public would save millions in fuel and in car-wreckage costs by use of a quiet and efficient fourth driving-range.—Thomas L. Fawick, in Milwaukee Section paper.

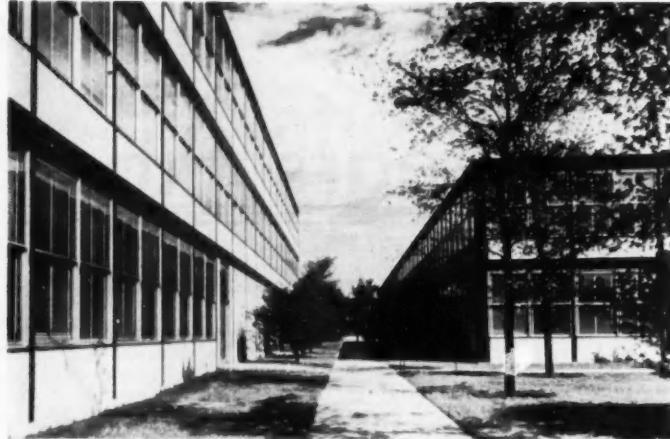
The use of auxiliary driving lights in which the beam is directed to the right of the car axis should be encouraged. In addition to affording better view of the right side of the road, this brightly lighted area tends to keep the driver's eyes directed away from oncoming cars.—R. E. Carlson and W. S. Hadaway, General Electric, in Semi-Annual Meeting paper.

Present-day disadvantages of the diesel engine as applied to motor vehicles are: fairly high weight per horsepower, comparatively slow speed, slow acceleration, difficulty in throttling to less than one-half speed, not enough flexibility, and the comparatively large radiator needed for cooling.

Changing a diesel engine to a flexible high-speed engine is a comparatively new idea and will necessitate a great amount of research and inventive ability for its accomplishment.—P. M. Heldt, Automotive Industries, in Indiana Section paper.

The great question today for transportation men is what services should be performed by motor-trucks. If five broad-minded railroad, truck manufacturers, and trucking industry men should meet for three days, lock the doors and let no one out, they would accomplish more in three days than we can in five years at the rate we're going.—F. I. Hardy, Boston and Maine Railroad, in Transportation and Service Meeting paper.

"What the automotive industry needs is less legislation in engineering and more engineering in legislation," note M. C. Horine and D. C. Fenner, International Motor Co., in Semi-Annual Meeting paper.



Mies Alley typifies the "new look" of Illinois Institute's campus

The SAE Student Branch at Illinois Institute of Technology comes by its "get-up-and-go" honestly. In a span of a dozen years, Illinois Tech has grown from a relatively small though competent school to one of the nation's top-ranking institutions of engineering and scientific education.

This impressive pace has been matched by the Student Branch. In 1946 SAE made its debut on the campus as a 50-member club. In two years enough interest was shown for the group to be granted a charter. The Branch currently has a membership of 104, to put it among the ten top Student Branches in the country.

The yearly program, heavy with professional content, includes meetings every three weeks, several industrial field trips, a joint meeting with Chicago Section and frequent attendance of Section meetings, exhibits for the annual Open House at the school, and an occasional picnic. Ronald Watson, Illinois Tech senior, placed first in Chicago Section's technical paper contest this year with his paper on two-cycle gasoline engines. Last year's contestant from Illinois Tech, Victor Pearson, placed second with a paper on propane.

The 85-acre campus of Illinois Tech, called Technology Center, is a nerve center for scientific and engineering activity of national and international significance. Allied organizations on campus are Armour Research Foundation, the Institute of Gas Technology, the central research laboratory of the Association of American Railroads, and the Institute of Psychological Services.

Located in the heart of a slum in Chicago's south side, Illinois Tech came up the hard way. It was founded in July, 1940, through the merger of Armour Institute of Technology and

Lewis Institute. Armour was founded in 1892 by the late Philip Danforth Armour of packing house fame. Lewis Institute was established in 1896 under provisions of the will of Allen C. Lewis.

Since 1940 the Tech campus has expanded from seven to 85 acres. This Herculean task necessitated the razing of slum dwellings, rehabilitation of displaced families, and the erection or improvement of building facilities.

The process will continue until a projected 110-acre campus is realized. Twelve ultramodern structures have been completed. A chapel is under construction, and a nine-story apartment building is nearing completion. Plans by Ludwig Mies van der Rohe, chairman of Tech's department of architecture, call for 58 additional buildings.

In recognition of the increasing social responsibilities of the engineer and scientist, more emphasis is placed on the arts and humanities at Tech than is common in technical schools. In addition to all basic engineering and scientific courses, students may take degrees in such subjects as city planning, fire protection, food engineering, gas technology, and visual design.

A large cooperative program is maintained, in which students spend alternate periods in school and at work for a given company. Off-campus extension programs have been established at Allis-Chalmers in Milwaukee, Caterpillar Tractor in Peoria, and the Argonne National Laboratory of the Atomic Energy Commission.

Dr. John T. Rettaliata, new 40-year-old president of Illinois Tech, encouraged the formation of the SAE club in 1946 when he headed the mechanical engineering department, and continues to have a keen interest in the welfare of the group.

SAE at

SAE members on campus offered invaluable aid to student members in the early years of the Branch. Wilson P. Green, chairman of the heat-power research department at Armour Research Foundation, was a guiding light in the formation of the club and its growth to charter stage.

Another helper in getting SAE on campus and a subsequent booster of its activities is William A. Casler, national chairman of SAE's Student Committee. Casler, assistant director of research at Armour Foundation, instituted the annual Chicago Section student paper contest in 1946, when he was student activity chairman of the Section. Chicago Section's current student activity chairman, Robert M. Ladevich, is also Student Branch adviser. An alumnus of Illinois Tech, Ladevich is now a supervisor in the heat-power department of Armour Research Foundation.

Student Branch officers are George Paul, chairman; Jay N. Foster, vice-chairman; and Roger Baird, secretary-treasurer.

"The boys deserve the credit. Tech's Branch has thrived with a minimum of faculty supervision," says Green. Chairman Paul personally conducted a membership drive last April which netted some 20 new members. Attendance at meetings is in the 75% bracket, high for a "streetcar college."

Detroit was the scene of the Student Branch's last field trip. The Cadillac plant, Ethyl Corp.'s research laboratory, and the Detroit Arsenal were inspected. Max Roensch, director of research for Ethyl, arranged a program that drew high praise from all.

Previous trips have taken students to South Bend, Ind., Kenosha, Wis., and La Grange, Ill. Trips are made in chartered buses and financed for the most part by Branch members. Leading speakers at meetings have included Dr. Rettaliata, an authority on jet propulsion, Ralph J. Duckworth of Oldsmobile, and Ervin I. Dahlund, chief engineer of Fairbanks, Morse and Co.

Student Branch contributions to campus life included several exhibits at the Open House in May, among them a cut-down German gas turbine airplane engine and a cut-down Flying Fortress engine. Both were driven with low-speed electric motors to show the action of the many moving parts.

Illinois Institute of Technology

SAE Members Who Attended Illinois Tech Include:

Andrew A. Affrunti (1949-51), John P. Ahr (1941-43), Guveren M. Anderson (1936-41), Robert B. Applegate (1944-49), Robert E. Arndt (1943-46), James L. Arthur.

Elmer R. Bartosek (1945-49), George A. Becker (1941-42), Leonard E. Bogue (1916), Herman Boxer (1946-47), Ralph C. Boyle (1926-34), Charles R. Bradlee (1945-49), Charles F. Bremigan, Jr. (1946-50), Daniel M. Brown (1938-42), Edward K. Brown (1937-39), Mott Q. Brunton (1900-03), John P. Buck (1942-48), William B. Buckman (1935-39), Roger Burley (1909-13).

William M. Cade (1938-40), Frank E. Cerveny (1937-39), Ralph C. Chesnutt (1908-10), Einar A. Comfield (1922-26), Howard Cooper (1909-13), Earle Cox (1948), Edward F. Cygan (1940-44), W. W. Davies (1929-33), Gordon E. Davisson (1927-31), Harold A. Doolittle (1937-40), William Douglass (1939-43), John J. Dreznas (1943-47), E. A. DroegeMueller (1933-37).

P. E. Eckberg (1940-46), Frederick H. Engelke (1940-41), Fred L. Faulkner (1911-15), Charles W. Finkl (1940-43), Arnett J. Franchi, Martin G. Gabriel (1944-47), Charles H. George (1937-41), Gordon A. Gettum (1944-46), R. S. Graafsmar (1940-42), Leonard F. Griffith (1942-48), James A. Guske (1946-50), Edward J. Gustaf (1941-46), Arnold A. Guttman (1946-48), Robert J. Gyllenswan (1943, 1946-49).

Ralph S. Hajek (1946-47), Richard A. Hameister (1939-43), Ernest W. Hedeon, Jr. (1940-43), George W. Hettrick (1940-48), Chester E. Hockett (1933-37), William H. Hulswit (1929-33), Sydney V. James (1903-07), V. J. Jandasek (1932-37), Howard Jarmy (1938-48), Harold R. Johnson (1939-43), Richard B. Johnson (1939-43).

Mahlen F. Kahler (1947-49), William M. Kauffmann (1922-26), Leonard H. Keeve (1946-49), M. J. Kittler (1925-29), John O. Kobzina, Jr. (1931-34), Arnold O. Kramer (1941-44), Albert E. Kraus (1933-36), Donald Krup (1947-51), Otto Kuehn (1918-22), Leonard M. Kulze (1937-48).

Robert M. Ladevich (1940-43), Z. J. Lansky (1941-44), C. M. Larson (1909-13), Edward H. Leavitt (1942-43), Henry G. Leiner (1939-41), Robert G. Lift (1939-43), Stephen M. Lillis (1930-34), Joseph Loch (1946-48), Robert L.

Logelin (1946-50), John B. Lukey (1930-34).

William P. Manos (1946-50), Joseph C. Margetic (1945-51), William H. Mashinter (1936-40), Robert L. Matson (1941-45), E. R. Maxfield (1942-43), I. E. McWethy (1937-38), Jacque L. Meister (1941-44), Robert F. Merkle (1945-50), George H. Miller (1938-40), Donald Y. Milne (1943-44), Raymond J. Minet (1945-48), Jon R. Morlen (1945-49), Guy F. Morris (1935-39), Henry G. Mueller (1942-45), Richard T. Mueller (1947-51).

Bertel S. Nelson (1936-41), Charles Nelson, Jr. (1926-27), John E. Nelson (1941-50), Fred Newman (1932-34, 1936-38).

William J. Nicholson (1946-50), Harry C. Nissen (1926-29), Robert W. Nordin (1947-51).

John M. Olson (1942-44, 1947-49), Harry N. Parsons (1907-11), Norman C. Penfold (1929-33), Richard A. Peterson (1936-41), Joseph F. Petrosius (1946-50), Oscar M. Pinsof (1925-29), Edward W. Policht (1945-49), Robert A. Pritzker (1944-46), Boleslaus F. Przybycin (1941-51).

Donald G. Reed (1946-47), Earl C. Rieger (1918-22), Daniel Roesch (1900-04), Lawrence M. Rogers (1939-43), Simon Ruttenberg (1930-32).

H. F. Sammons (1934-39), Frank W. Sauger, Milo M. Schalla (1937-41, 1942-44), Walter E. Schirmer (1927-31), Robert W. Scott (1936-40), Pierre V. C. See (1900-04), F. B. Selensky (1918-20), Daniel B. Shaw (1916-17), William C. Shrier (1949-50).

George H. Sites (1946-49), Charles L. Small (1941, 1945-48), Donald W. Smith (1926-30), Earl H. Smith (1913-17), Burton K. Snyder (1940-43), Louis Speidel, Jr. (1930-35), Sheldon P. Stein (1939-43), Porter E. Stone (1900-08), Donald F. Stranberg (1939-40), Clinton E. Stryker (1915-17), Robert R. Svenson (1943-47).

Michael J. Thomas (1922-26), E. Arthur Thompson (1945-46), J. W. Tierney (1913-17), George J. Tzantzos (1947-49), John J. Udry (1935-38), George A. Underwood (1943-47).

John Waldherr, Jr. (1936), Guy F. Wetzel (1912-16), Harold S. White (1914-17), M. G. Whitfield (1925-29), Donald E. Willard (1901-05), Donald E. Wing (1943-45), Donald W. Wing (1942), A. H. Winkler, Jr. (1926-30), H. R. Youngkrantz (1931-35), Joseph A. Zerkel (1924-26).



Officers of the SAE Student Branch at Illinois Institute of Technology at work in the laboratory are (left to right): George Paul, chairman; Jay N. Foster, vice-chairman; and Roger Baird, secretary-treasurer.

CALENDAR

Section Meetings

Dayton—July 10

Dayton Country Club. Dinner: 7:00 p.m. Golf Jamboree. Members only. Golf from 1:00 p.m. until dinner. Prizes. Steak dinner partly subsidized.

The following Sections will not hold any meetings for the summer months.

Chicago	Washington
Milwaukee	Williamsport

National Meetings

Meeting	Date	Hotel
1952		
WEST COAST	Aug. 11-13	Fairmont, San Francisco
CENTENNIAL of ENGINEERING BANQUET	Sept. 4	Hotel Knickerbocker, Chicago
TRACTOR and PRODUCTION FORUM	Sept. 8-11	Schroeder, Milwaukee
AERONAUTIC, AIRCRAFT ENGINEERING DISPLAY, and PRODUCTION FORUM	Oct. 1-4	Statler, Los Angeles
TRANSPORTATION	Oct. 22-24	William Penn, Pittsburgh
DIESEL ENGINE	Oct. 30-31	Chase, St. Louis, Mo.
FUELS and LUBRICANTS	Nov. 6-7	The Mayo, Tulsa

1953

ANNUAL MEETING and ENGINEERING DISPLAY	Jan. 12-16	The Sheraton-Cadillac, Detroit
PASSENGER CAR, BODY, and MATERIALS	March 3-5	The Sheraton-Cadillac, Detroit
PRODUCTION	March 25-27	Statler, Cleveland
AERONAUTIC and AIRCRAFT ENGINEERING DISPLAY and AIRCRAFT PRODUCTION FORUM	April 20-24	Hotel Governor Clinton, New York City
SUMMER	June 7-12	The Ambassador and Ritz-Carlton, Atlantic City, N. J.
INTERNATIONAL WEST COAST	Aug. 17-19	Georgia Hotel, Vancouver, B. C.
TRACTOR and PRODUCTION FORUM	Sept. 14-17	Hotel Schroeder, Milwaukee

Dual-Purpose Plant Makes Good Sense, But—

Based on paper by

EDGAR F. KAISER

Kaiser-Frazer Corp.

On any basis of economy and savings, the dual-purpose plant has a marked advantage over new facilities. It makes use of what exists and it saves manpower because organizations can move into problems as a unit, without dislocation of personnel and labor. By contrast, costs of new plants are heavy in terms of manpower, material and money. But can industry afford the dual-plant?

If defense work is done in new plants, the cost of construction and operation, plus profit, is borne by the Government—or by the people. Savings are made in time and material, but industry must change its regular procedures. The cost of the change must be accepted as being a legitimate charge. But when industry returns to civilian production, the process must be reversed and the charges are not allowable. Obviously the dual-purpose plant makes good sense from the Government standpoint, yet corporations accepting the theory are penalized while companies building new facilities are rewarded. (Paper, "Conversion—A Continuing Policy?", was presented at SAE Dayton Section, Dayton, Nov. 28, 1951. It is available in full in multilithographed form from SAE Special Publications Department. Price 25¢ to members; 50¢ to non-members.

Device for Studying Single-Cylinder Engines

Based on paper by

WALTER CORNELIUS

and

JOHN D. CAPLAN

General Motors Corp.

This paper will be printed in full in SAE Quarterly Transactions

To overcome the limitations of orifice-type meters and the variations caused by changing atmospheric conditions in conventional air metering systems used for single-cylinder engine investigations, a system was devised which combines accurate measurement of air flow with precise control of air consumption and inlet air conditions under all manner of operations.

In this system, high pressure air

from a compressor is fed through a pressure reducing valve to provide a steady supply of air at 60 psi. The air is then discharged into a 4 cu ft primary supply tank remotely controlled by a pressure regulator under the control of the engine dynamometer operator. The regulator controls the air flow control valve at the entrance to the primary supply tank. From this tank the air passes through one of four critical flow nozzles which are provided with valves for manual selection. The air temperature may then be adjusted by means of remotely controlled immersion type electrical heaters, and the air discharged subsequently into a 4.5 cu ft secondary tank located above the carburetor. Similar heaters are provided at the intake manifold to regulate temperature of the fuel-air mixture entering the intake port.

Ability to regulate air consumption has proved useful in matching full throttle indicated mean effective pressures and octane requirements of single-cylinder engines with those of automotive multi-cylinder engines over the normal speed ranges. Engine and fuel variables can be studied on a single-cylinder engine and the results applied directly to automobile engine practice. The system has also proved

useful in obtaining reproducible octane ratings of fuels and octane requirements of single-cylinder engines. Its greatest value, however, is its ability to measure air consumption accurately. (Paper, "An Improved System for Control and Measurement of Air Consumption of a Single-Cylinder Engine," was presented at SAE Annual Meeting, Detroit, Jan. 17, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to non-members).

Based on Discussion

J. F. Alcock
Ricardo & Co., Ltd.

WE, too, have had to abandon low-pressure orifices for engine air metering on account of pulsation errors. Complex smoothing systems of capacities and resistances in series improve smoothing in general, but are liable to have resonances in the working range. Flabby rubber bags, like an inner tube with a loose wire helix inside to limit collapse, give fairly good smoothing at pressures near atmospheric.

A further error may occur through

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inaccurate pressure-averaging at the manometer connections. A satisfactory solution is to use linear-resistance elements. We use pads of dense felt $\frac{1}{2}$ in. in diameter $\times \frac{1}{2}$ in. thick. They have a high resistance, so care must be taken to avoid leaks in the manometer connections.

Torque Measuring For Tractor Take-Offs

Based on paper by

W. E. GUSTIN

John Deere Waterloo Tractor Works

TWO types of apparatus have been developed for measuring torque transmitted in tractor power take-off shafts. One type employs a hydraulic torque meter, the other uses the strain gage. With the hydraulic torque meter, the torque in the shaft is transmitted through a planetary gear system in a housing mounted on the tractor drawbar support. The reaction of the planet pinions is transmitted to the stationary sun gear which is coupled directly to two pistons in cylinders which are part of the main housing. The resulting hydraulic pressure in the cylinders is transmitted through a common connector to a pressure recorder.

Torque fluctuations are too rapid to be observed, hence it is necessary to make a record of the pressure which can be measured.

In the second type, four strain gages placed on the shaft at 45 deg to the axis of the shaft are connected in a Wheatstone bridge circuit so that maximum output is obtained for torsional strains. The arrangement of gages is such that strains due to bending, end thrust, and temperature are cancelled and only torque registered. Here again, torque fluctuations are so rapid that it is necessary to photograph the oscilloscope trace in order to get an accurate measure of torque peaks.

Comparative laboratory and field tests of both types of apparatus indicate that accurate and comparable results are obtained for all torque fluctuations including torque due to rapid engagement of the tractor clutch, and that the tractor manufacturer could well afford to use both types. The hydraulic type is larger and more difficult to install than the strain gage pickup, but has the advantage of being a self-contained, portable unit providing a record that can be observed and studied during the test, and requiring no external power.

The strain gage type requires a portable electric generator when used for field tests, but it has the advantage of easy installation. It will record torque in either clockwise or counter-clockwise direction, and can be adapted for

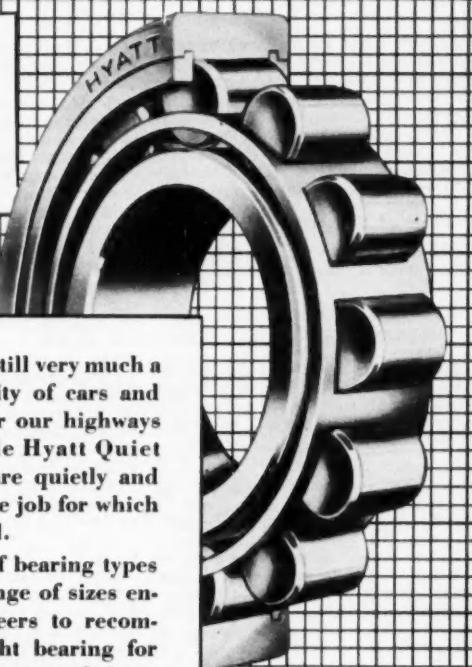
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numerous other torque measurement requirements. (Paper, "Torque Measuring Apparatus and Technique" was presented at SAE National Tractor Meeting, Milwaukee, Sept. 13, 1951. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Summary of Discussion

Questions from the floor and Gustin's replies were as follows:

Q. Is there a direct recording oscillograph good enough to get accurate results?

A. Yes, there are several types available on the market that will record torque signals which have a frequency response accurate enough to record torque fluctuations.

Q. How is the hydraulic torque meter installed on the output shaft? How is the power delivered to the implement?

A. The spline on the input shaft is coupled directly to the tractor output shaft. Power is delivered to the implement through the planetary gear system. The planet gears turn with the power shaft and the torque re-

action is transferred to the sun gear. The sun gear does not rotate.

Q. Has any thought been given to applying a constant torque drive in the output to give a steady torque?

A. Torque fluctuation during measurement can be smoothed out with any type of hydraulic equipment. The hydraulic coupling, however, is not practical because speed is not maintained from input to output.

John Page, Caterpillar Tractor Co. stated that they had trouble getting the timer to maintain exact frequency and wanted to know how John Deere did it.

Gustin explained that on hydraulic equipment, the timer is driven by a condenser, resistor and tube combination off the battery. It is checked with strain gage torquemeter, the frequency a stop watch before the test. With the of the portable electric generator is adjusted so that it is 60 cycle. This is done by adjusting the speed of the engine.

E. G. McKibben, U. S. Tillage Machinery Laboratory, told the gathering that an instructor named Burrough at Purdue University had developed a mercury slip ring pickup.

Differences Mark Automatic Transmissions

Based on paper by

FREDERICK H. SOLMES

Kaiser-Frazer Corp.

HERE, briefly, are salient features of automatic transmissions:

Overdrive: Of the many developed, the Borg-Warner is perhaps best known. It consists of a planetary gearset attached behind a conventional three-speed transmission which reduces the drive ratio by 30%.

Electro-Matic: Uses an automatic dry disc clutch operated by engine vacuum in combination with an overdrive and conventional three-speed transmission. Formerly on the Packard.

Drive-Master: Represents a refinement in use of the overdrive transmission. As found on the Hudson, the vacuum clutch operation is combined with self-shifting controls which operate between second and high with the shift lever placed in high.

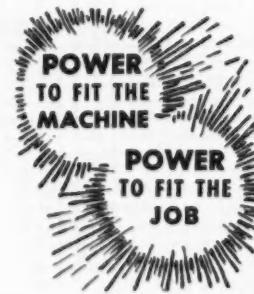
Fluid Drive: The fluid coupling was the first step in hydraulic drives. This coupling in combination with a conventional clutch and transmission is now standard on the Dodge. It serves as a cushioning member to reduce the starting slip of the friction clutch and to reduce drive vibrations.

Presto-Matic, Fluid-Matic: Comprises a self-shifting, constant mesh transmission in combination with a fluid coupling and friction clutch. Developed by Chrysler. The work of shifting was done by vacuum cylinders in earlier models, but is now done hydraulically. The four speed transmission is now available with a torque converter in lieu of a fluid coupling in the Chrysler.

Hydra-Matic: One of the earliest fully automatic types, first used on the Oldsmobile and now available on Olds, Cadillac, Pontiac, Nash, Lincoln, Kaiser and Hudson. The unit is composed of a fluid coupling with a transmission having three planetary gears providing four forward speeds and reverse. Shifts are made hydraulically under full power and are varied depending upon car speed and engine torque requirements.

Dynaflow: Developed for Buick as the first production torque converter. It comprises five elements—pump, turbine, auxiliary pump, and two stators mounted on over-running clutches. The gearbox, installed behind the converter has a double pinion planetary gearset to give extra low and reverse ratios.

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Powerglide: As used in Chevrolet it has a five element torque converter with multiple pinion planetary transmission to provide extra low and reverse gears. The converter incorporates an extra set of vanes inside the torus section which acts as an auxiliary fluid coupling and increases the resistance between pump and turbine members.

Ultramatic: A Packard product composed of a four-element torque converter—pump, stator and two turbine members—multiple pinion planetary gearbox, and a direct drive clutch.

Automatic Drive—Studebaker: A Borg-Warner product comprising a three-element torque converter, a direct drive clutch, and gearbox having two planetary gearsets and two over-running clutches, producing two forward gear ratios and reverse.

Ford-O-Matic, Merc-O-Matic: A fully automatic transmission built by Borg-Warner and Ford. It comprises a three-element torque converter with multiple pinion planetary gear system to produce two forward gear ratios and reverse. The drive is always through the converter as it is with the Dynaflow and Powerglide.

These transmissions represent varied solutions to approach the ideal. Progress may be expected in obtaining more efficient torque converters and better combinations of converter and gearing to give completely smooth transmission under all conditions. It is significant that the five most recent drives to be developed use a torque converter. (Paper, "Automatic Transmissions—Existing Types," was presented at SAE Detroit Section, Jan. 28, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

required for the main end posts at the floor line, while the coupler carrier members must resist a vertical force of 100,000 lb in either direction. The latter provision is aimed at keeping draft and underframe members in line and preventing either of two coupled cars from climbing one over the underframe of the other.

Destruction of side walls in case of side swiping or overturning is guarded by the provision that the total minimum section modulus of side frame vertical members about a longitudinal

axis, at the weakest point, shall not be less than 3/10 times the distance in feet between centers of end panels. A further measure for resistance to overturning is found in specifications which demand that the projected area of roof in square feet divided by the sum of the section moduli of the carlines shall not exceed 100. Section moduli requirements are based on open-hearth steel, but may be modified in proportion for metals having higher elastic limits. (Paper, "Railroad Passenger Safety and Comfort," was pre-

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FUEL INJECTION EQUIPMENT FOR DIESEL ENGINES

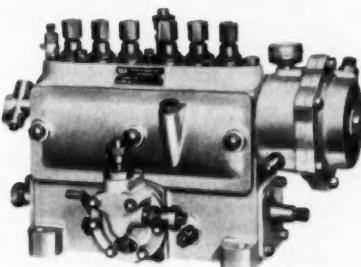
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Based on paper by
ALLEN W. CLARKE
American Car & Foundry Co.

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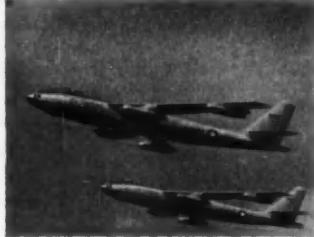
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sented at SAE Annual Meeting, Detroit, Jan. 16, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to non-members.

Based on Discussion

Dr. Ross McFarland, Harvard School of Public Health, wanted to know why sleepers were not designed so that all transverse berths were against the forward wall. Clarke said this was not done because of the need to economize on plumbing. By placing the toilet beside the rear wall of one compartment which is the forward wall of the next rearward compartment, one drainpipe can be used for two toilets.

Asked by H. H. Kerr, U. S. Rubber, why longitudinal berths are made up so that the head lies forward, Clarke answered that he thought it just custom, adding that when he traveled in such a berth he placed one of the pillows against the forward wall.

Tests of Used Oil From Railroad Diesels

Based on paper by

LELAND A. WENDT

Shell Oil Co.

SINCE additives in a new oil fulfill very definite and important functions, it is important to be able to evaluate a used oil to determine if it is still capable of doing its job. A heavy-duty oil is exposed to conditions which cause the additives present to be consumed. The base oil may not be worn out in the final sense, but the additives are consumed. If engine operation is sufficiently severe when this point is reached, an increased rate of engine deterioration can be expected.

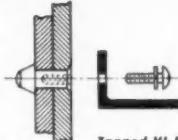
Thus far there are no widely accepted analytical tests used to evaluate additive effectiveness, but we have found two rather simple tests which are reasonably significant for evaluation of the oxidation inhibitor and the dispersant detergent. These are the blotter test and dark field microscope inspection.

Blotter tests can tell a great deal about oil in a general way, provided samples are taken regularly and some background is established. The nature of the inner spot indicates whether or not the oil has dispersive qualities. The color of the outer spot is roughly indicative of the presence of soluble oxidation products in the oil, the oil containing a large quantity showing a dark brown color. And the presence of water can be detected.

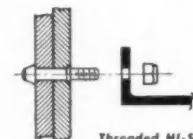
In dark field tests, the light reaching the oil sample is supplied so that no rays pass directly into the microscope barrel, but enter it only as they are re-

REGULAR HI-SHEARS save weight, time and space when fastening structure

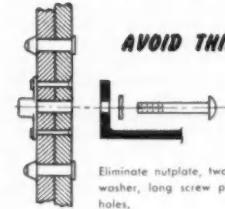
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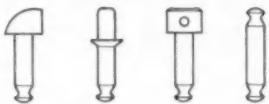


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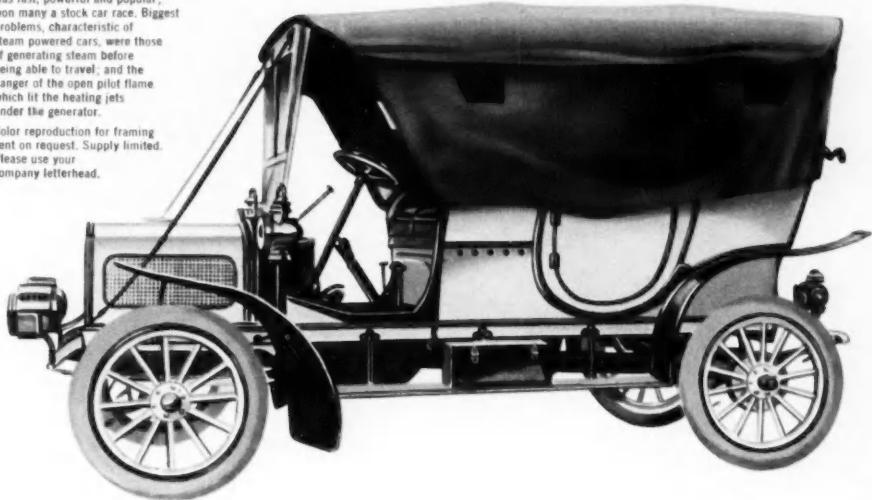
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the low amplitude range experienced in occasional running and jumping. Any design effort seeking to achieve optimum values from the human operator, therefore, must provide a ride within this range. Any other range must result in disturbances to the human organism however great human tolerance may appear for the short term.

Experiments show that the greatest improvement in tractor ride comfort resulted from using a seat whose natural frequency and damping characteristics most nearly approached the val-

ues accepted for modern passenger car suspension. (Paper, "Tractor Ride Research" was presented at SAE National Tractor Meeting, Milwaukee, Sept. 10, 1951. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Summary of Discussion

Dr. Edward R. Dye, Cornell Aeronautical Laboratory, Inc., pointed out that tractor and fighter plane vibration problems and methods of insulating the operator are similar, and that

test instrumentation is similar. The over-all riding comfort problem is more serious in tractors than in fighter aircraft, he said, because the operator's body is supported at quite some distance above the center of throw and its motion is thus amplified. In the fighter airplane, however, the operator is seated more nearly on the longitudinal axis through the center of gravity.

Low frequency, high amplitude, and transverse motion of the seat swing the operator's weight out of alignment with his vertebral column. To bring himself back to a vertical position, the operator has to exert pull on his muscles, thus exerting increased pressure on all of the vertebrae "bearings." This pressure is additive to the forces created by vertical vibration which get through the insulation device. Since fatigue is measured by wear on these "bearings," the operator tends to become overfatigued and the fatigue is cumulative because his body does not recover in time for the next day's work. With present knowledge it is possible to design a stabilized platform that will anticipate and correct most of this motion.

Apropos of this, Simons said, while delivering his paper, that he believed the Germans had a tractor which incorporated the seat, platform and controls—a very desirable feature.

Harold L. Brock, Ford Motor Co., stated that no matter how good the seat, if operation of the controls is difficult, the result is the same. The seat should be so placed that controls can be operated without discomfort.

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U. S. Urged to Develop Jet Transports

Based on paper by

R. W. RUMMEL

Chief Engineer, Trans-World Airline

MOST needed is a positive American approach to the problem of developing and building a commercial jet transport plane. The approach should be aggressive on the part of the manufacturers, supported by the airlines, to produce the desired machine.

Development of a prototype would involve an investment of \$30 million to \$40 million, but such development is essential if American manufacturers are to preserve their markets.

No jet transport airplane is now being constructed in the United States. In contrast, Great Britain has a number of new-type transports flying and in production. The DeHavilland Comet, for instance, is an all-jet airplane and has been delivered in some quantities to British Overseas Airways. United States' international air-

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planes will probably feel the first impact of jet competition from Great Britain.

The United States' industry can more than make up the ground presently lost, but may find competition rough sledding for a certain period of time.

(Paper, "Commercial Turbine Powered Transport Outlook," was presented at SAE Kansas City Section, Jan. 29, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to non-members.)

Condenser is Nub Of Car Cooling Problem

Based on paper by

T. C. GLEASON

Chrysler Corp.

If summer comfort is to be improved, the only alternative to refrigeration is ventilation and more of it. Excellent ventilation can give substantial comfort for temperatures up to 85 deg and

EVEN THE MOST

Violent Vibration



CAN'T REDUCE THE ACCURACY OF

RUGGED

Rochester

GAUGES



Specially designed for heavy-duty service, Rochester Tractor Gauges are built with vibration and pulsation dampeners.

There's no danger of accuracy loss through rough riding. Even high overloads can't damage their sensitive movements, or cause their pointers to flutter. They keep on delivering accurate readings, too, year after year, because of their unusually rugged construction.

And for extra protection, Rochester gauges are permanently sealed behind heavy glass crystals. Dirt and water just can't get in. This outstanding dependability has made Rochester Gauges the choice of all leading tractor manufacturers for more than 35 years.

Rochester

Manufacturing Company, Inc.
21 Rockwood St., Rochester 10, N.Y.



possibly approaching 90 deg, and since the higher temperature is only occasionally reached in some highly populated areas of the country, it would seem wise to explore the possibilities of ventilation much further. It would be much less expensive than mechanical refrigeration and the chances are it would answer majority needs.

To hasten the coming of cooling by refrigeration it would be well to move the condenser and evaporator into the trunk. The current practice of locating the compressor on the engine where it may affect balance and suspension is poor; so is locating the condenser in front of the radiator and stringing long refrigerant lines from the front to the rear of a car.

The critical component is now, and will be, the size and location of the condenser. It must be as small as possible for car installation. It would appear that the mechanical vapor compression system is the type of cooler most likely to succeed because the absorption, steam ejector, or air cycle systems require two to three times the heat exchanger size. (Paper, "A Survey of Heating, Ventilating and Air Conditioning of Car Bodies", was presented at SAE National Passenger Car, Body, & Materials Meeting, Detroit, March 4, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to non-members).

Discussion from the Floor

To a statement that people complain that air is too dry in winter heating systems and that it is hard on nasal systems, Mr. Gleason replied that it had not been proved that the suffering was general, also that if dew point temperature was raised it would result in condensation on windows.

Queried as to what effect light paint on car roofs had on inside temperatures, Gleason answered that there is none if the car is moving.

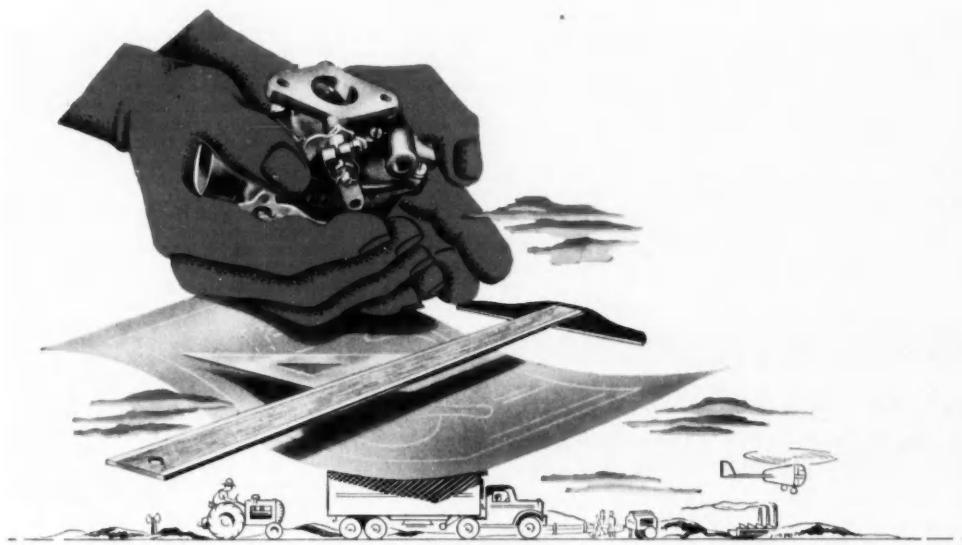
Proving Grounds Assure Better Product

Based on paper by

FRANK WATSON

International Harvester Co.

BEFORE a new truck model hits the proving grounds its components will have been subjected to specific laboratory tests. Engines may have been under observation for two years or more and prototypes given proving ground tests in current model chassis. Laboratory tests will have been given



Look to field application engineering to increase your engine performance

For many years, in many diversified markets, Marvel-Schebler has concentrated on designing and adapting carburetors to meet individual requirements.

In order to satisfy all kinds of load demands, in all kinds of weather, Marvel-Schebler has relied on performance data supplied by field application engineering to help engine manufacturers obtain carburetors of proper design and calibration.

This has resulted in a constantly expanding wealth of experience in carburetors and carburetion for a wide range of applications. In the farm field alone, where rugged strength and unusual dependability provide that extra margin of economy in operation, 6 out of 10 farm tractors are using Marvel-Schebler carburetors as original equipment.

This experience can be of great help to you in the proper selection of standard equipment from the Marvel-Schebler line or in any of your carburetion problems. It is yours for the asking.

MARVEL-SCHEBLER PRODUCTS DIV.

Borg-Warner Corp., Decatur, Ill.



MARVEL - SCHEBLER
Carburetors

transmission and rear axle; frame and cab will have been checked for stress concentration, using stress-coat and strain gages. It is only after components are thought to have approached desired standards that experimental chassis are built for trial at the Fort Wayne and Phoenix proving grounds.

At Fort Wayne, one of the vehicles goes on the twist and torture course to bring out immediate weaknesses which are corrected before a longer trial is given to reveal weaknesses in frame assembly and cab and sheet-

metal mountings. Then follows the Belgian Block Test, basic to evaluating cab and sheetmetal life, cab and radiator mountings, springs, tire carriers, and the like. Simultaneously a second chassis is subjected to tests for such items as: economy and acceleration performance, cooling, brake performance and life, steering geometry, efforts and turning angles; cold starting, heater performance, summer ventilation, visibility, and driver comfort.

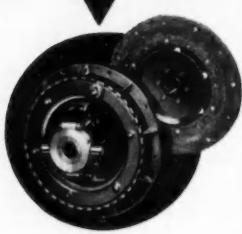
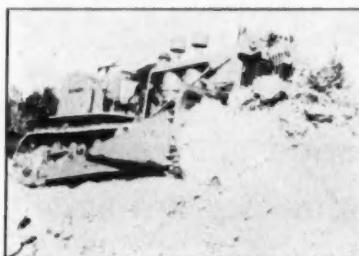
Defects revealed by the accelerated tests at Fort Wayne are corrected be-

fore vehicles are sent to Phoenix where the test course simulates customer operation only with above average severity. Here the chassis is loaded and is run for 24 hours daily over a 7½ mile endurance course and 5 mile rough course. Some grades are steep enough to require truck-trailer combinations to use low to get down them and about 25 shifts are required for each lap of the track.

Facts on failures or difficulties, no matter how trivial, are relayed to the Engineering Department so that remedial action can be taken. The Phoenix personnel is likewise expected to solve problems and often does so.

Proving grounds, in the company's estimation, assure the operator that his truck will have a greater life, longer periods between overhaul, more power, better economy, lower oil consumption, less weight, better accessibility, and improved riding comfort. (Paper, "Why Proving Grounds and How We Benefit from Them," was presented at SAE Metropolitan Section, May 1, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price 25¢ to members; 50¢ to nonmembers).

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Geared to Move Big Loads

Every part of this rugged ALLIS-CHALMERS tractor has strength to carry the toughest loads it's ever meant to move—and more—with a maximum margin of safety. Heavy-duty ROCKFORD CLUTCHES help it deliver more efficient, more productive work cycles. Let ROCKFORD engineers help you design dependable power transmission.

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ROCKFORD CLUTCHES



What America Needs For the Car of 19xx

Based on paper by

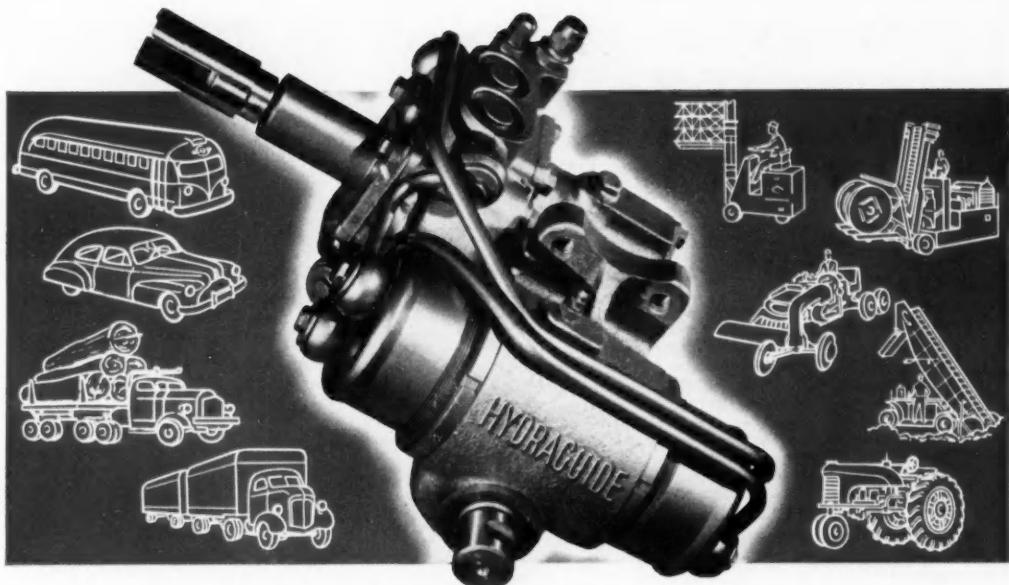
ALEX TAUB

Taub Engineering Co.

THE Model T and the Chevy of 1927 and 1928 were sold at an approximate value of four months' worker wages, while today, with our advances in design, tooling, and in wages, it takes six month's worker wages to buy the minimum car, the backbone of the industry. What is needed for the car of the future is engineering development in the low priced field.

For incorporation in X we suggest:

1. Bore-stroke ratio of 0.75.
2. Increase displacement 10% by decreasing piston displacement per dollar and decreasing weight per cu in.
3. Increase allowable compression ratio to 10:1 to obtain better fuel consumption using 80 octane fuel as maximum.
4. Base fuel consumption improvement on road loads. Modified gain in fuel consumption for actual driving should be from 50% for the hard driver to 60% for the conservative driver.
5. Maximum brake torque increased 25%, 10% increase for piston displacement, 15% increase due to less friction.



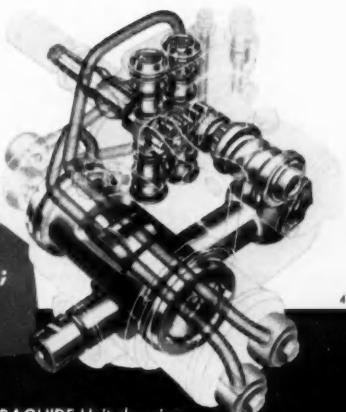
GEMMER HYDRAGUIDE—Hydraulic Power Steering

UNIT TYPE—complete—self-contained—not an accessory or booster, no valves or tubes exposed to snow, ice, mud, gravel, etc. from road. • PROPORTIONAL COMBINATION of hydraulic power and manual steering. • PROPORTIONAL VALVING—power always proportioned to steering load, light or heavy. • VALVES positively actuated—not spring-centered, hence no static load or "valving step" in steering "feel." • Instant response of power—no lag as you move steering wheel. • PERFECT STEERING CONTROL—"road feel" at all vehicle speeds. • FULLY SELF-RIGHTING. • LESS "WINDUP" on steering wheel—higher safe speeds in heavy vehicles. • STEERING WHEEL doesn't "fight" if the vehicle strikes an obstruction or blows a tire. • GEMMER HYDRAGUIDE was the first successful power steering for passenger cars. HYDRAGUIDE for heavy vehicles is the ultimate for buses, trucks, road machinery, and other heavy units. With reasonable care a Gemmer Steering Gear will last the life of the vehicle.

GEMMER MANUFACTURING CO.
6400 Mt. Elliott • Detroit 11, Michigan

HYDRAGUIDE TAKES THE "STEER" OUT OF STEERING;
THE DRIVER GUIDES THE VEHICLE INSTEAD.

Phantom of HYDRAGUIDE Unit showing
exclusive proportional valving.



AMERICAN CHEMICAL PAINT COMPANY
AMBLER PENNA.

Technical Service Data Sheet
Subject: RUST PROOFING WITH PERMADINE®

INTRODUCTION:

Ferrous metal parts that have been Permadized in a zinc phosphate chemical solution and then "sealed" with a rust-preventive oil such as "Granoleum" are effectively protected from rust-damage. In addition, if the surface is accidentally chipped or scratched, rusting is confined to the exposed area.

Rust proof coatings find many practical applications. During World Wars I and II most small arms were rust proofed by phosphate coating and impregnated with chromic acid and a rust preventive oil, or cutback petroleum. This not only provided excellent corrosion resistance but also yielded a dull black non-reflecting surface. Rust proof finishes are now used widely on hardware, firearms, cartridge clips, metallic belt links, miscellaneous forgings and castings, tools, unpainted replacement machine parts, and many other similar items such as bolts, nuts, and washers.

THE PERMADIZING PROCESS:

For the most effective rust proofing of large or small work in large or small production, "Permadine" is used in tanks in an immersion process, with the bath heated to 190°-210°F., coating time 20 to 30 minutes. The coated parts are then rinsed in clean water, and then in a controlled dilute acidulated solution. After drying, a suitable corrosion-resistant oil such as "Granoleum" is applied.

Operations can be carried out with the work in crates, or hung from hooks, utilizing an overhead rail and hoists. For large volume production, automatic equipment can be used to mechanize the line. Small parts can be treated in tumbling barrels.

"PERMADINE"

MEETS

SERVICE

SPECIFICATIONS:

The protective "Permadine" finish meets U.S.A. 57-0-2C; Type II, Class B, and equivalent requirements of:

MIL-C-16232,

Type II

U.S.A. 51-70-I,

Finish 22.02, Class B

AN-F-20

Navy Aeronautical M-364

JAN-L-548

"PERMADINE" DATA CHART

Type of coating	Zinc phosphate
Object of coating	Rust and corrosion prevention
Typical products treated	Nuts, bolts, screws, hardware items, tools, guns, cartridge clips, fire control instruments, metallic belt links, steel aircraft parts, certain steel projectiles and many other components
Scale of production	Large or small volume; large or small work
Method of application	Dip Barrel tumbling, racked or basketed work
Equipment notes	Immersion tanks of suitable capacity. Cleaning and rinsing stages can be of mild steel. Coating stage can be of heavy mild steel or stainless steel.
Chemicals required	"Permadine" No. 1
Pre-cleaning methods	Any common degreasing method can be used. Alkali cleaning ("Ridolite"), Acid cleaning ("Decofine"), Emulsion cleaning ("Ridolene"), "Ridoline"); vapor degreasing, solvent wiping, etc. are examples. Acid cleaning may need to follow other cleaning methods if rust or scale is present.
Bath Temperature	190° - 210°F.
Coating time	20 - 30 minutes
Coating weight range Mgs./Sq. Ft.	1000 - 4000
Technical Service Data Sheets	No. 7-20-1-2 T. M. No. 5



WRITE FOR FURTHER INFORMATION ON "PERMADINE"
 AND YOUR OWN METAL PROTECTION PROBLEMS



higher volumetric efficiency and higher compression ratio.

6. Maximum bmeep increased 15% or more.

7. No change in hp per cu in.

8. Shorten wheelbase in proportion to present short seating space, modifying suspension and unsprung weight to give equivalent ride.

9. Reduce curb weight in low price class to 2700 lb, medium class to 3300 lb, and high price class to 3600 lb.

10. Select an axle ratio that will give the best fuel consumption with the equivalent existing acceleration.

11. Provide a fuel system injecting directly into the combustion chamber.

12. So shape the combustion chamber that, conjunction with proper injection, will give a stratified mixture throughout the chamber, being rich at ignition area and lean at end of burn area.

13. Use non-exhaust valve type engine, or self-cooled exhaust type such as the single valve.

14. Eliminate vapor lock.

15. Eliminate variations in starting due to heat and cold by fuel injection.

16. Use a greater percentage of fuel fractions by elimination of fuel in intake manifolds.

The times we live in require a 40% increase in mpg with a fuel that can be made with a minimum of steel equipment and buildings per 100,000 barrels of crude, a minimum use of octane additives, and freedom from vapor lock by engine design to permit broader use of undesirable light ends. (Paper, "Mechanical Octanes, The Answer to 'X' Equals What", was presented at SAE Southern New England Section, Hartford, Conn., Nov. 8, 1951. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

**Solving Problems
 Of Tractor Vibration**

Based on paper by

P. L. MIKESKA

International Harvester Co.

ATTEMPTS to reduce vibrations in tractors have had little success because of the complexities inherent in design and the multiple combinations resulting from hitching implements direct to the tractor. Absorbing en-



**Men who depend
on power...know
they can depend
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Every CUMMINS DIESEL is built not once but twice

Truckers have learned to count on Cummins Diesels for dependable power day in, day out.

What's behind this consistent reliability? One good reason is the fact that every Cummins Diesel is actually built *twice*. After initial assembly, and run-in testing, every engine is disassembled, inspected; then reassembled and tested again.

This extra care—together with Cummins' economy-proved fuel system and efficient parts and service organization—makes lightweight, high-speed (50-550 h.p.) Cummins Diesels a wise first choice for men who depend on power.

Whatever your power needs, your Cummins dealer is the man to see.

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CUMMINS ENGINE COMPANY, INC., Columbus, Indiana

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With an organization like Bendix behind your dealers, complaints about unavailability of parts will be a thing of the past. Bendix has many other advantages to offer you . . .

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BENDIX RADIO DIVISION of
BALTIMORE 4, MARYLAND



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gine vibrations by rubber mountings is not practical. Tractors are extremely narrow and in most cases the engine is part of the frame, hence a structural member. Furthermore, power transmission differs from the conventional automotive propeller shaft.

In this paper, the author presents a possible approach to the complex problems of vibration by using the Natural Frequency Equation. The assumptions are given as well as the initial and final equations which are based on a 4-cyl vertical type engine and tractor chassis. (Paper, "The 'Natural Frequency Equation' Applied to Farm Tractors", was presented at SAE Annual Meeting, Detroit, Jan. 15, 1952. It is available in full in multi-lithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

Saving Steel Tonnage Through Parts Salvage

Based on paper by

V. A. WOODLING

Caterpillar Tractor Co.

HEAVY demand for earthmoving equipment parts in the face of material shortages makes imperative a program of parts conservation. Thousands of tons of steel could be saved through salvage of track links, rollers, and shoes by proper use of welding material.

Track shoe wear occurs only on the extended grouser and a worn grouser promotes wear through loss of traction or increase in slippage, hence rebuilding before excessive wear is advantageous. Shoes having grousers worn within established limits can be restored by welding bar stock over the grouser. Build-up bars are inexpensive, welding skill can be average, and the gain in wear life more than justifies the cost.

If the grouser wear is moderate, perhaps 3/8 in., application of wear metal alone may be justified, but common practice is to permit wear to go beyond the point where weld metal alone will suffice. Track shoes on a large tractor can be restored with 300 lb of bar stock and 60 to 70 lb of electrode whereas replacement would require one ton of steel.

When track links are worn so that interference exists between roller flanges and link bosses, continued operation only results in complete destruction of rollers, links, and other track frame parts. The ideal time for resurfacing comes when the original

link has worn through its hardened surface. If welded then, the basic link structure remains strong and the resurfacing is least expensive. Link salvage is not difficult but it is time consuming. Weld overlays have been found to offer the best solution. On large tractors, resurfacing with 80 to 100 lb of electrode will save a ton of replacement steel.

Roller life can be extended by maintaining proper track adjustment and alignment, and lubricating the rollers

correctly. Excessive wear only adds to their destruction as well as to failure of links and other parts. Wearing surfaces can be restored to useable size with wear metal provided service is not delayed. Wear can progress beyond the original depth of hardness to a point where there is no longer clearance between roller rim flanges and the extended pin bosses of the links, but original hardness is the better point.

A properly restored roller should give

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better than half the life of a new one, and restoration can be repeated indefinitely. A roller weighing 90 lb initially can be restored with 4 to 6 lb of electrode and thereby save 840 lb of replacement steel. (Paper, "Used Parts—Valuable Assets," was presented at SAE Earthmoving Industry Conference, Central Illinois Section, Peoria, April 10, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

Engine Capacity Hinges on Gulp Factor

Based on paper by

J. C. LIVENGOOD
A. R. ROGOWSKI
and

C. FAYETTE TAYLOR

Massachusetts Institute of Technology

This paper will be printed in full in SAE Quarterly Transactions

In this paper, the authors present their findings in studying the problem of the volumetric efficiency of four-stroke engines, and discuss in detail the effect on this efficiency of such factors as: operating variables, piston speed, inlet-valve flow capacity, cylinder design, and size. They point out that the gulp factor, the inlet valve Mach index, is a critical design parameter in designing any type of reciprocating engine or pump so as to obtain high volumetric efficiency, and they explain how this factor can be used to guide engineers. (Paper, "The Volumetric Efficiency of Four-Stroke Engines," was presented at SAE Annual Meeting, Detroit, Jan. 18, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

How to Reduce Probe Radiation Errors

Based on paper by

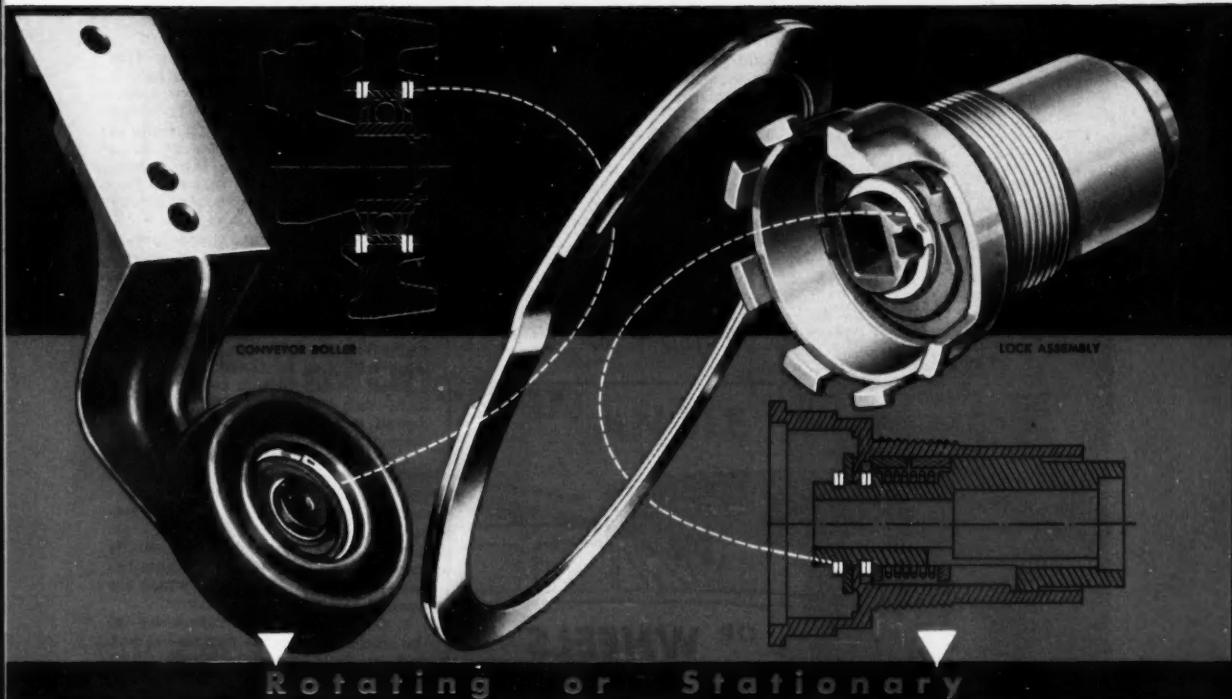
E. MARSTON MOFFATT

The Airflo Instrument Co.

This paper will be printed in full in SAE Quarterly Transactions

THE common assumption that a probe will come into equilibrium with gas temperatures at any temperature or velocity level, or that the error at high temperature can be easily calibrated

there are hundreds of ways in which Industry uses SPIROLOX to solve retaining problems



**assemblies retained with Spirolox look neater,
last longer, use fewer parts, are easier to take apart and put together**

Wherever parts rotate, wherever parts are to be secured on shafts or in housings, wherever moving parts must hold together — Spirolox Retaining Rings do the job better! Even on rotating assemblies, as shown in the conveyor roller application at left above, Spirolox attains neat, compact, simplified design. The stationary application of a lock assembly (right above) illustrates how Spirolox can be applied in those hard-to-reach places where the retaining ring must operate in a very confined space.

Exclusive Spirolox Design makes possible a variety of applications that is almost limitless. Secret of this design is the patented Spirolox *two-turn construction*, which **ELIMINATES THE GAP** and makes possible a **UNIQUE LOCKING CHARACTERISTIC**. A step or offset, formed in the ring so that the two turns are parallel, *bridges the gap* found in conventional retaining rings. Result: better conformability, even in the most restricted places. The effective locking property of Spirolox is created by a "friction lock", formed under thrust between the two turns. Result: greater holding power to make the ring STAY PUT in its groove.

The success of Spirolox construction proves itself not only in superior operation. It also makes possible easier installation, less-complicated machining, simplified servicing and quicker dismantling of assemblies retained the Spirolox way. These compact spring-steel rings spiral into their grooves easily, saving many man-hours in manual installation. Spirolox Rings adapt easily to fixtures for automatic production line installation. They eliminate costly machining and special tools. Spirolox Rings facilitate maintenance and servicing in the field because they come out at the flip of a screwdriver, ready for re-use. Thus, factory-adjusted or assembled units **REMAIN UNCHANGED**, even after repeated dismantling operations during servicing or repairs.

HANDY, ILLUSTRATED SPIROLOX CATALOG is yours without cost or obligation. It may be your key to simpler, lighter, more compact machinery or parts. If you wish, send us a print of your product and our engineers will point out Spirolox application possibilities. Ramsey Corporation, St. Louis 8, Missouri.

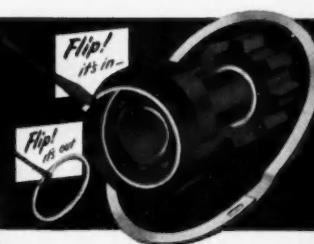
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and allowed for, has to be abandoned as temperatures approach or exceed 1000 F and velocities increase to 2000 fps and more.

The temperature level is so important for radiation that radiant heat losses from a body, other things being equal, are about 250 times as much at 1600 as at 60 F. This loss is responsible for the radiation error of a probe. As velocity increases the effective gas temperature at the probe increases in terms of static temperature. For a cylindrical shape perpendicular to flow this increase amounts to about 200 F at 2000 fps due to adiabatic compres-

sion as the gas strikes the probe and to shear work done on the boundary layer of the gas as it flows around the probe. The latter accounts for the fact that it is impossible to design a "static temperature" probe. It is possible to design a chamber which will stagnate the gas around the temperature element so that the probe will measure very close to "total temperature."

For low-temperature, high-velocity work, total temperature probes with very little radiation shielding can measure gas temperatures accurately to within 1 or 2 F. At the same veloc-

ity and about 1200 F, scaled up versions of these probes would still have a negligible velocity error, but a radiation error of 30 to 40 F. The latter can be reduced by allowing the gas to flow past the thermo-element at a higher velocity to give a higher convection heat input, but this reduction is purchased at the price of a higher velocity error.

Low velocities in flue gasses are at the other extreme from high-velocity measurement. The radiation error is so high as to give an advantage to accelerating the gas flow past the temperature element and accepting a slight velocity error in return for a large reduction in radiation error.

Other design factors beside gas velocity can be manipulated to reduce overall error, but they never take its place. Among them are:

1. Controlling the emissivity of the probe. Since the radiation is directly proportional to this variable, a low-emissivity covering on the thermo-element is very effective.

2. Shielding the thermo-element by interposing shields of various types between element and the walls which are usually at a lower temperature.

3. Controlling the temperature of the shield between the thermo-element and the walls by auxiliary means such as an electric heating coil. This has not proved practical and it has some serious theoretical objections. (Paper, "Multiple Shielded High Temperature Probes—Comparison of Experimental and Calculated Errors," was presented at SAE Annual Meeting, Detroit, Jan. 17, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

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- Carburetors
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- Dashpot Mechanisms
- Vacuum Booster Pumps
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58th Street and First Avenue • Brooklyn 20, N.Y.

Data Reduction System Devised for up to Mach 1

Based on paper by

C. N. SANFORD

Iowa State College

THE conventional system of reducing flight-test data to standard conditions can be expanded to include the effects of compressibility and the change in wing lift caused by the steep climb or steep glide.

Such a system—applicable to all subsonic speeds and to large angles of climb or glide—is developed in the paper "A System of Reducing Flight Test Data to Standard Conditions."

The position error functions for both the incompressible case and the compressible case are worked out and are

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STANDARD STEEL SPRING CO.
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Gary, Ind.
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Detroit, Mich.

shown to be a single curve and a family of curves respectively. Flight testing for the position error and applying the position correction to the air speed indicator and altimeter readings are discussed for both the incompressible and compressible cases. (Paper was presented by title at the SAE Annual Meeting, Detroit, Jan. 17, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Strength Factor In Spur Gear Design

Based on paper by

R. P. VAN ZANDT

Caterpillar Tractor Co.

GREATERT accuracy in the manufacture of gears has led designers of spur gears to modify the original as-

sumption that all the load was carried at the tip of the tooth, and to assert instead that the load should be considered shared with the other pairs of teeth until the latter goes out of the load zone. From this they assumed that the highest bending stress occurs only after contact has moved down the tooth to the place where it must carry the whole load. On the basis of this assumption the tooth appears about 60% stronger, which leaves the designer with the problem of deciding whether or not his gears are accurate enough to justify this substantial increase in load carrying capacity.

To solve this problem, the author of this paper presents a method for determining whether to use the higher or lower strength factor, and a method of specifying the required accuracy on a gear drawing necessary to justify the use of the higher strength factor. (Paper, "Beam Strength of Spur Gears—When to Use the Higher or Lower Strength Factor", was presented at SAE Annual Meeting, Detroit, Jan. 15, 1952. It is available in full in multilithographed form from SAE Special Publications Department: Price: 25¢ to members; 50¢ to nonmembers).

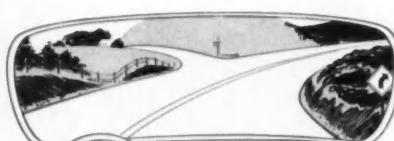
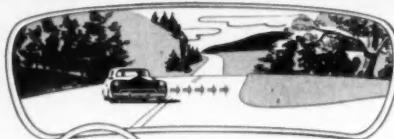
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How to Get the Most Out of Lantern Slides

Based on paper by

B. A. JONES

Ethyl Corp.

A SLIDE should be used with one or more of four purposes in mind:

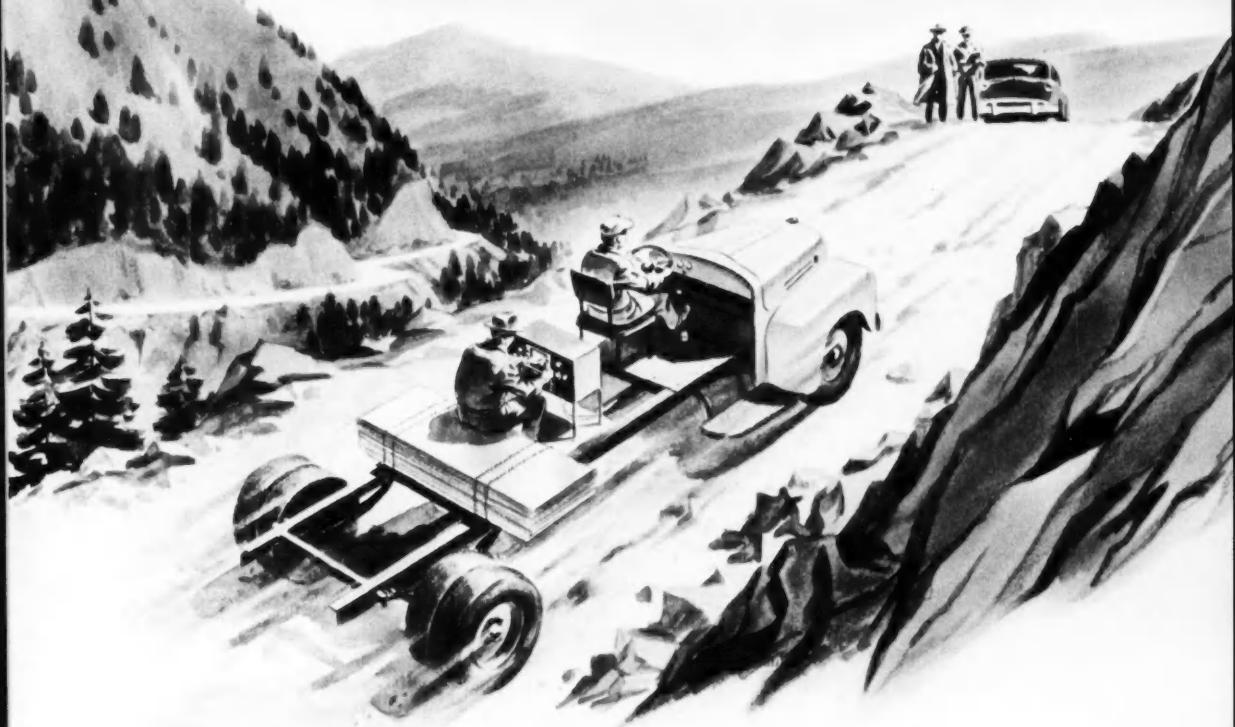
1. To clarify an idea.
2. To emphasize an important point.
3. To help the speaker follow an organized plan of presentation.
4. To enhance the interest and thereby hold audience attention.

Following this statement of purpose, the author tells clearly and concisely how to present material to highlight it and this involves such items as letter size, mechanical lettering, use of color, simplifying data to avoid confusion, titling and subtitling, when to use bar charts or tables, proper lighting, timing, and a host of other small but vital details.

Anyone who ever has used, or plans to use, slides to illustrate a technical paper will find a wealth of practical information in this paper which is nothing less than an 18 page compact working manual. If used, it could not help but raise the level of technical presentations and make a rarity of the all too-common accomplishment of presenting data upside down, blinding the

Spicer

SPECIALISTS IN SERVICE



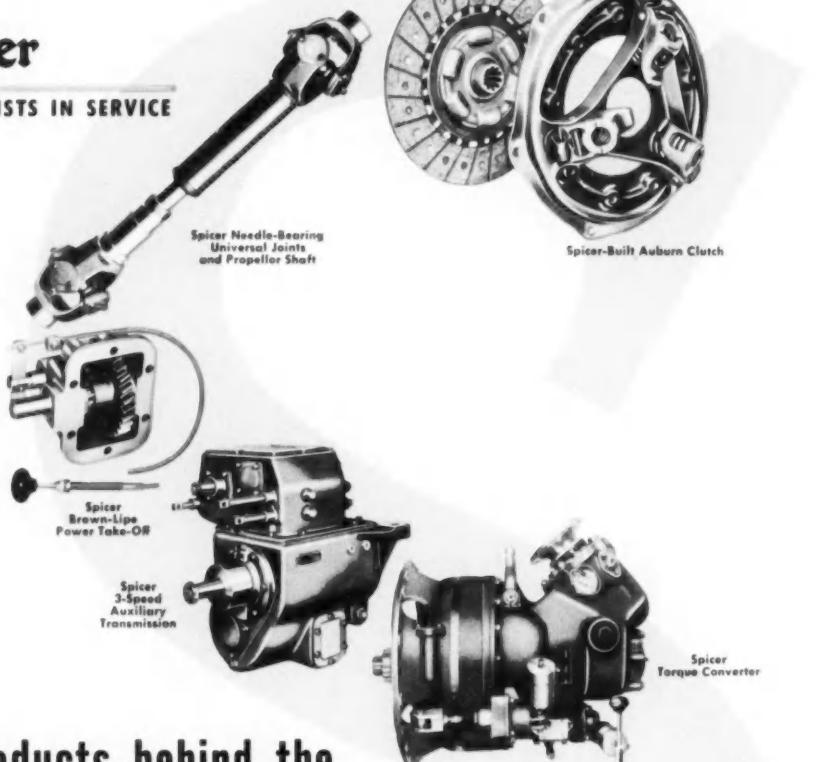
the spirit behind the famous Spicer name

The whole automotive industry knows the Spicer spirit, and the men behind it. They...and the Spicer men before them...have pioneered, engineered, tested and proved many of the outstanding advancements in the automotive power transmission field. They...and the Spicer men before them...have manufactured these units in large volume for availability to every American automotive vehicle ever built. They are men who have kept product above price. Yet they have kept production so efficient that quality standards have never been impaired by quantity schedules. With their heads, their hearts and their hands, these men...and the vast Spicer organization behind them...are working for you.



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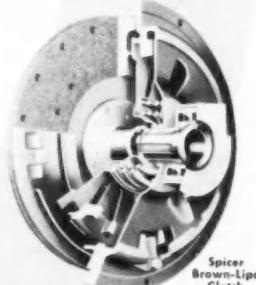
The products behind the famous Spicer name

SPICER builds nearly a half-century of designing and manufacturing experience into its products...and backs these products with a service policy that assures long-range protection to the user.

THE SPICER line meets a large majority of the power transmission needs in passenger cars, trucks, buses, tractors, rail cars, and railway generator drives.

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SPICER "BROWN-LIPS" GEAR BOXES • POWER TAKE-OFFS • POWER TAKE-OFF JOINTS • RAIL CAR DRIVES • RAILWAY GENERATOR DRIVES

audience, then putting it to sleep. (Paper, "Make Slides Worthwhile," was presented at SAE Annual Meeting, Jan. 16, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to non-members.)

How Sheet Metal Affects Car Design

Based on paper by

EARLE S. MacPHERSON

Ford Motor Co.

SHEET metal in the body represents more weight than any other component part of the car. In our new model it may be 25 to 30% of the total. The extent to which we can hold down this weight element and its cost will be governed somewhat by available selections of sheet and the tolerances we have to take. Tolerances commonly appear to be about 10% and this 10% means about 60 lb on the average car. This may seem relatively unimportant, but if design is approached with the idea that even 6 lb is unimportant, we end up with an unduly heavy car.

Wide sheets often seem thicker at the center. Thickness near the edges may be the minimum required by the structural design or the processing in dies, hence the extra thickness in the middle represents excess and undesirable weight. We also find the gage of sheet steel coil varying along the length of the coil and here again, while the gage may be the minimum required, parts made out of the thicker portions represent excess weight in the car.

We would like to be able to get thinner steel of good deep draw quality at no extra cost, specifically, a 21 gage that draws as well as the 20 gage does now. This would not necessarily lead to tinniness because the shape into which the metal is drawn is more important than a small change in gage. We can shape panels to avoid tinniness and still use lesser gages.

The heavier the body and sheet metal, the bigger the engine and drive line components, brakes and tires required to meet acceptable standards of performance and durability and the less favorable the fuel economy. It all ends up as increased first cost and operating cost to the car buyer. (Paper, "Sheet Metal and Its Effect on Body Style and Design" was presented at SAE Detroit Section, Oct. 19, 1951. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Continued on Page 136

SAE JOURNAL, JULY, 1952

NEW STANDARDS
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ADEL TYPICAL 3000 AND 1500 PSI,
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ADEL TYPICAL 1500 PSI, 4-WAY POPPET
TYPE DIRECTIONAL CONTROL VALVES

**AN6210-1 and -2, AN6211-1
and -2**



ADEL TYPICAL 3000 AND 1500 PSI,
SHUTTLE VALVES—AN APPROVAL ON
ALL DASH NUMBER VARIATIONS

**AN6209, AN6217; AN6277
and AN6278**



ADEL TYPICAL 3000 PSI, ADJUSTABLE,
POPPET TYPE RELIEF VALVES

AN6279-4, -6 and -8



ADEL TYPICAL 1000 TO 2100 PSI
CRACKING PRESSURE, THERMAL
RELIEF VALVES

AN6245A4



ADEL TYPICAL 1500 PSI, POPPET TYPE
CHECK VALVES

AN6247-2



ADEL TYPICAL 1500 PSI, ADJUSTABLE,
PISTON TYPE RELIEF VALVES

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Modern Higher Output Engines Create Lube Problems for Airlines

Based on paper by

Harry N. Taylor United Air Lines, Inc.

* Paper, "Airline Experience With Aircraft Engine Lubricating Oils," was presented at SAE National Aeronautic Meeting, New York, April 18, 1951.

THE lubrication requirements of the high output engines placed in service in transports over the past few years have stressed existing high quality oils beyond their capabilities. Exhaust valve stem lubrication is one of the most difficult encountered, and the problem grows greater as attempts are made to increase specific outputs through higher operating mean effective pressures, or through the use of exhaust drive turbines.

Need for a more durable exhaust valve guide material has brought ni-resist cast iron materials into general use. They are more durable than the aluminum bronze type but they aggravate the lubrication problem because they are not as good a bearing material and they raise the temperature of the exhaust valve stem because of poor heat transfer characteristics.

Exhaust rocker box coking is another problem. The coke so produced is carried through the engine causing stoppage of critical oil passages and excessive accumulations on engine oil screens. This condition is also due to the inadequate dissipation of waste heat from the exhaust port region. Considering the much greater volume of oxygen available in the intake rocker boxes and the absence of coking in these boxes, temperature is obviously the primary consideration.

Ring sticking, which followed upon the introduction of the tapered compression ring, has been due largely to mechanical warpage of the piston ring lands, especially where a 15 deg (included angle) ring is used. Excessive amounts of carbon accumulate behind the tapered rings, particularly when engines are operated for long overhaul periods, and this prevents proper ring action because the ring is prevented from moving inward as the piston moves up into the choked cylinder barrel.

Oil carbon deposits, which accumulate at the extreme upper limit of travel of the top piston ring, have contributed to many piston failures. These deposits, which accumulate during cruise operations when the cylinder head is expanded by heat, can seize the top ring land of the piston during a subsequent starting and warming up when the cold cylinder head reduces the diameter of the cylinder barrel top.

Despite emphasis on cylinder barrel wear, it is a lesser problem. But wear is an important problem at a number of points. As overhaul periods are in-

creased, wear of oil control rings becomes critical. At the 1400-1500 hr period commonly used, the wear on the oil control ring makes oil control a problem. Most operators have discontinued lapping of all control rings to prolong life.

Extension of overhaul periods makes engine oil consumption more important; where supply is limited, high consumption may limit the operating range. It may also foul plugs, although the effect is minimized by the high heat range plugs now in use. High oil consumption is usually a good indication of piston ring and/or piston ring land deterioration and as oil control weakens, piston ring land failures tend to increase. (Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to non-members).

Based on Discussion

By E. A. Ryder

Pratt & Whitney Aircraft Division

Failure to regard oil as a structural material is one reason why troubles still exist. It is as definitely an essential material of construction for engines as steel and aluminum are.

Improvements in oil performance can be made by adding the right chemicals, but it is also easy to bring on new troubles. It is certainly possible to find an improved oil which will be harmless but more testing will be required to do this. The oil problem won't be settled simply by changing from piston to jet engines. Requirements of the latter will be different but just as difficult to satisfy.

Use of Scrapers In Open Pit Mining

Based on paper by

DONALD SAXTON

Hanna Coal Co.

ARGE shovels are unquestionably the most economical tool for the removal of rocky overburden in the strip

mining of coal, because the material need only be handled once. When small shovels, draglines, wagons, and scrapers are used, the time taken in handling or rehandling the material runs up the cost per yard. However, not all stripping lends itself to large shovels. It depends on the extent of the operation, the percent of slope of the overburden, and the operator's capital as to what tool will be used.

There are many and varied uses for scrapers in strip mining. When there are small yardages of material to handle, or operations are scattered, and when material is free of rock, scrapers and wagons can be superior. They are also used for removal of refuse and the stockpiling of coal.

Although relative costs are hard to figure accurately it is safe to say that stripping with scrapers costs about 15 to 20 cents a cubic yard, while with small shovels and wagons the cost drops to 10 to 15 cents, and with large shovels to .03 to .06 cents, less depreciation. Choice of equipment bases on two considerations: First, equipment should handle secondary as well as primary operations to justify capital investment. Secondly, and this depends upon the first consideration, most operators lack the capital to invest in specialized machinery and they must use what they have to maintain production. (Paper, "Factors Affecting the Application of Scrapers and Wagons in Open Pit Mining of Bituminous Coal," was presented at SAE Earthmoving Industry Conference, Central Illinois Section, Peoria, April 9, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

Neglect Research And See What Happens

Based on paper by

J. P. CARROLL

Caterpillar Tractor Co.

THIS paper tells the story of the rise and fall of the Avery Co., manufacturers of agricultural machinery, which reached its zenith in 1920 to become Peoria's largest enterprise. In tracing the history of this company, the author offers his explanations as to why it failed despite the inventive genius and high promise manifest in the products it brought on the market. (Paper, "A Case for Engineering, Research and Training," was presented at SAE Central Illinois Section, Peoria, Ill., Dec. 17, 1951. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to non-members).

New Members Qualified

These applicants qualified for admission to the Society between May 10, 1952 and June 10, 1952. Grades of membership are: (M) Member; (A) Associate; (J) Junior; (SM) Service Member; (FM) Foreign Member.

Atlanta Group

John A. Alexander (A), Howard F. Steiner (SM).

Buffalo Section

Fred Kurt Kunderman (J), William W. Reeves (A).

Canadian Section

Sydney Bowes (M), John Clare (J), Sulo Armas Holli (M), Charles E. Marceau (A), W. E. Mulholland (A), Lloyd Arthur Swindel (A), Arthur S. Walker (A).

Central Illinois Section

Edward Charles Ackerman (J), Harvey J. Christensen (J), Charles Neal Fangman (J), Harold M. Johnson (M), Donald W. Knopf (J), William Jackson Lux (J), Joseph Edward Perryman, Jr. (J), Raymond Paul Poyner (J), Gilbert Tribley (J).

Chicago Section

Edgar H. Ayers (M), A. Berg (A), Henry Robert Bileter (M), Robert K. Gornall (M), LeRoy A. Grotto (J), Robert W. Halberg (M), Norvin P. Kinder (J), William B. Love (M), W. G. Mitchell (M), Anton John Pros, Jr. (J), Paul C. Rathje (J), C. R. Recor (A), Harold J. Rennpage (M), William Charles Schumacher, Jr. (J), John Louis Smith (M), Fred G. Wacker, Jr. (M), Robert E. Wahlstrom (M), Ralph L. Wetzel (A), George R. Zielinski (M).

Cincinnati Section

James F. Green (M), Herman G. Holt (A), Joe E. Mellen (A), Owen L. Negangard (M).

Cleveland Section

Jack R. Allen (A), Carl W. Goldbeck (J), John J. Haffer (J), James R. Hastings (M), Cecil G. Martin (M), William R. Miller (M), Joseph Potieny (M), David B. Prescott (J), William C. Reinberger (J), Gene P. Robers (A), Leo E. Schamadan, Jr. (M), William Howard Sherwood (J), Frank J. Svekric (A).

Colorado Group

George N. Brock (M), Lowell M. Higgins (A).

Continued on Page 136

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Designers,
Engineers

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New Members Qualified

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Dayton Section

Wunibald I. E. Kamp (M), Herbert Henry Kouns (M), Roy A. Lawrence (J), Nelson Eugene Smith (SM).

Detroit Section

John F. Adamson (M), Walter C. Anderson (J), Borden H. Baumgartel (J), Harold John Bergum (M), Marvin J. Bloink (M), Robert H. Briggs (M), Richard Cass (J), Herbert I. Chambers (M), William Christensen (M), Gordon Wilfred Ellis (J), Joseph A. Fortin (J), Lynn S. Gruesbeck (A), John W. Guterman (J), Raymond Joseph Happley (J), Carl S. Hoffman (M), Laurence M. Howarth (M), Virgil L. Illes (M), Leonard J. Jankowski (J), Adolf Walter Jarema (J), Hayes E. Johnson (M), Kenneth A. Krieger (M), Duane William Lane (A), Richard L. Liskow (M), Francis Xavier Marsh (J), Clifford M. Marttila (J), James L. McNamara (J), Fred F. Miller (M), Thomas H. Mitzelfeld (J), Edward L. Nash (J), Edward J. Naudzus (M), John Paterson (J), Ellis B. Rifkin (J), James E. Rissman (J), Thomas H. Rochford (M), Loyal J. Rodgers (M), Joseph V. Rogers (J), William H. Schomburg, Jr. (A), Mathew H. Schumer (M), Karl Schwartwalder (M), Arthur H. Smith (M), John H. Stickney (J), LeRoy Stram, Jr. (M), Charles W. Tremor (A), Rolland B. Wallis (M), Robert M. Weier (M), James P. Wiegang (M), Vernon Stephen Yerebeck (J).

Hawaii Section

Yutaka Hirata (A), George M. Wheelwright (M).

Indiana Section

Dale A. Cue (J), Jack D. Lineberry (J), Clarence Milton Nordman (J).

Kansas City Section

Donald Steve Papas (J), Carl S. Phillips (M).

Metropolitan Section

John E. Kasch (M), Albertus E. Schmidlin (M).

Mid-Continent Section

Robert A. Forsman (M), Russell Edward Linnard (J).

Mid-Michigan Section

Frank William Ball, Jr. (J), Charles R. Hagler (M), Arnold N. Schuppert (J), Henry S. Smith (M).

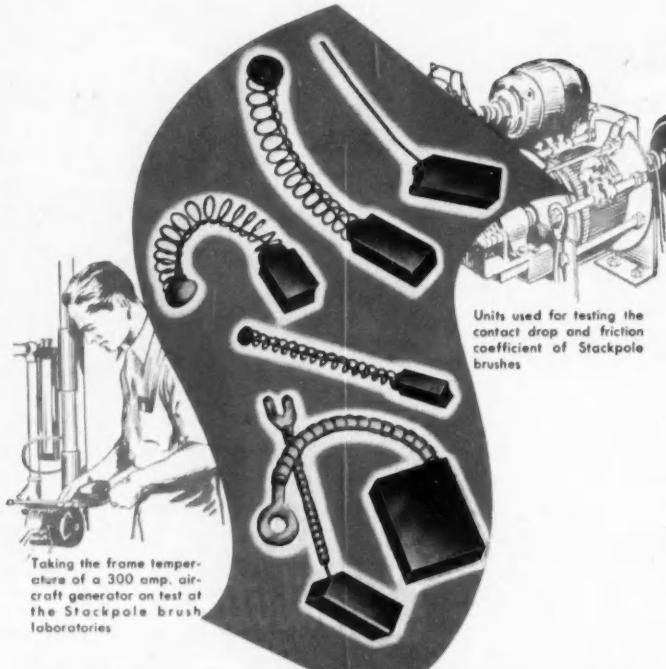
Continued on page 138

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Montreal Section

Jean Claude Lanoie (J), David J. Munro (M), A. T. Sherpitis (A), Sumer Wolf (M).

New England Section

Daniel J. Lynch (A), Allister William Shepherd (A), William Tornrose (A).

Northern California Section

William Ortman Lampkin (M), Harold D. Otto (A), Earl Thiessen (A).

Northwest Section

Victor C. Condon, Jr. (A), J. C. Johnson (M), Roy Arthur Martin (M).

Philadelphia Section

Herman Duchin (A), Claudius A. Greco (J), William D. Hackett (A), Eli Rubinstein (J), William E. Schmidt (J), Ralph W. Speiser (M), Roland Spressart (J), George F. A. Stutz (M), Raymond F. Winch (J).

Pittsburgh Section

C. R. Betts (M), J. A. Stein (M).

St. Louis Section

Herbert R. Dippel (A).

San Diego Section

William Howard Bancroft, Jr. (J), Ira J. Hassad (A), John A. Logan, Jr. (M), Bruce A. Willsey (M).

Southern California Section

Joseph C. Haile (A), Robert R. Henley (M), Nick G. Stasinos (J).

Texas Section

Harold C. Anderson (A), L. C. W. Patton, Jr. (A), Edwin A. Schonrock (A), Ray C. Slay, Jr. (J).

Virginia Section

Raymond E. (Pete) Heath (SM), Lawrence E. Sizer (A).

Washington Section

Frederick P. Babcock (A), Bruce Davidson Clark (M).

Western Michigan Section

Roy E. Kaashoek (A).

Continued on Page 140



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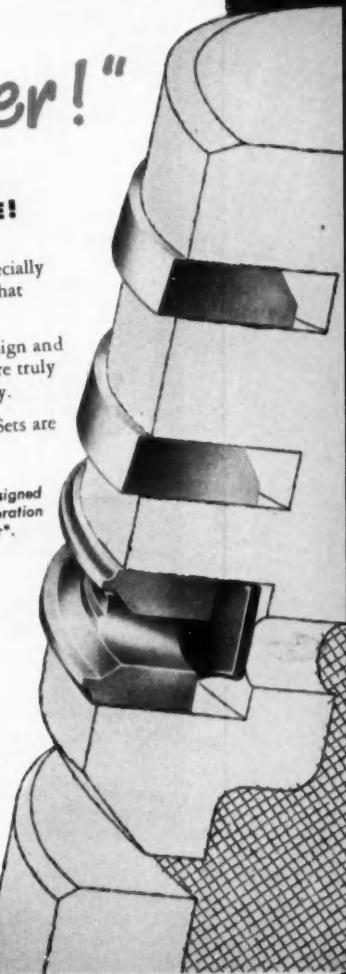
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A set of service rings designed by Muskegon in collaboration with the engine maker*.



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New Members Qualified

Continued

Williamsport Group

Elbert Brunner Reynolds, Jr. (J).

Outside of Section Territory

Edward Horton Fletcher (M), George Francis Fritz, Jr. (J), John E. Lane (A), Edwin F. Lawrence, III (J), Wesley Moore (M), Clinton Patton (A), John H. Pollock (M), Russell Schucker (A), H. Vernon Seymour (A).

Foreign

Pierre Auvray (FM), Belgium; Hansjorg Bendel (FM), Switzerland; Major Thomas John Robert Bright (FM), England; Jose Anselmo da Silva (J), South America; Henry Godefroy (FM), Germany; Bhau Yeshwant Kadam (FM), India; Ernest Edward New (FM), England; K. P. Poll (FM), Holland; John Albert Radford (J), England; A. P. S. Rapozo (A), England; Donald G. Rawden (FM), Australia; Arthur James Smith (FM), England; Mantosh Sondhi (FM), India.

Applications Received

The applications for membership received between May 10, 1952 and June 10, 1952 are listed below.

Baltimore Section

Joseph A. Levens, Eldon J. Shorek.

British Columbia Section

Frank J. Berto, Robert Elvin Munroe Gordon, Ralph Benjamin Kelleway.

Buffalo Section

Richard D. LeClair, Herbert G. White.

Canadian Section

Roy E. Brown, Lewis Garden, Hals-welle W. Hadden, George P. Henderson, John Geoffrey Holland, John Edis Rymes, Zygmunt Karol Smolana, William Stirling, S. A. Taylor.

Continued on Page 142

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Colorado Group

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Central Illinois Section

George Adelbert Fisher, Orville F. Hudson, Erwin J. Janicke, Sydney B.

Genz, John Gilbert Hamner, Richard Wright Kizer, K. Ward Lampert, William G. Loveridge, Jr., John Franklin Morgan, Jr., Milford B. Morgan, Jimmy D. Myers, Louis B. Neumiller.

Jones, Robert W. Meyer, Robert F. Nolan, Otis A. Schmidt, Fritz W. Schnackenberg, Edmund J. Sebastian, Edward M. Smith, Ronald Watson, B. R. Winborn, Jr.

Chicago Section

John L. Coursey, Allyn R. Erickson, B. L. Fisher, Jay H. Forrester, Russell A. Graham, Edward Howe, Richard G. Hudson, Erwin J. Janicke, Sydney B.

Cleveland Section

Harold C. Andrus, Johan-Otto Gustaf Bjorling, Joseph C. Donato, Mike A. Hernandez, Robert H. Johnston, Paul A. Likly, Wade Hampton Moore, Jr., Eugene Andrew Reitz, Robert C. Tupa.

Dayton Section

Glenn W. Somers, Glenn H. Lewis, Thomas Edward Morton, Edwin L. Shaw, Leo Alfred Wack.

Detroit Section

William Leonard Aldrich, Jr., Andrew Badarak, Charles Lambert Baker, Donald G. Bamford, Gilbert F. Bonner, David Borodawkin, Dr. Frederick W. Bowditch, Burton Hugh Bouwkamp, George C. Campbell, E. R. Carolin, Herbert E. Clark, Stanley Carl Clemence, J. R. Coffron, Ervin A. Domzal, Robert L. Emmett, Thomas M. Fisher, Howard Robert Field, Edward J. Flewelling, Jr., William S. Gale, Gerald F. Gass, Jr., E. F. Glance, Raymond A. Gollon, Ralph L. Groen, Charles F. Gruber, Stanley L. Janky, Lyle L. Jannisse, Aloysius John Kaminski, Cecil N. King, Fred S. Kerr, L. L. King, Ernst F. Klessig, George Malecki, John Y. McMillan, Edgar Richard McPhee, Ronald M. Middleton, Noral A. Nelson, Curtis P. Parsons, Edwin J. Pierisma, Henry Plonski, Carl Sherwood Rice, William E. Rice, Paul H. Rofkar, John A. Sahs, Louis Sibal, Foster Earl Stough, Charles H. Sumner, William M. Swan, Jr., Paul M. Tudor, LaVerne R. Voss, LeRoy A. Volberding, Richard L. Webber, G. B. Wiklund, Robert K. Williams.

Hawaii Section

Ivan B. Palmer.

Indiana Section

Ralph Edgar Schumann, Joseph B. Snoy.

Kansas City Section

Arthur C. Searle.

Metropolitan Section

Herbert J. Bayley, Jr., Howard M. Brown, Marion S. Jozefowski, Harold Frederick MacHugh, Paul Petrella, Francis P. Raquet, Robert George Reeves, Naseem Ahmad Siddiqui, Seymour Steiner, Albert R. Thomas, James E. Vevera.

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Milwaukee Section

Charles C. Devine, Alvin Palmer Fenton, John Robert Liggett, Edward A. Meeves, Frederick N. Schmidt, Otto F. Widera.

Montreal Section

Edward William Baker, G. E. James Blaiklock, G. D. A. Bray, Norman Edward Delmage, Charles A. Dinsmore, Leslie Wyatt Foster, Jr., Robert B. Keefer, Otis Mason, Edward Needham, Raymond O. Overby, K. C. Paape, Robert F. Pomeroy, Stanley J. Willis.

Northwest Section

Sid R. Head.

Philadelphia Section

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Salt Lake Group

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Joseph Anthony Canavespe, Robert E. Dudley, Bill Fortenberry, Luke Johnson, Franklin Arthur Landers, Hollis W. Smith, Andy Calvin Zugar.

Virginia Section

James Alfred Beckett, T. W. Curry.

Washington Section

Joseph A. Alber, David L. McBride.

Wichita Section

Harold C. Goldthorpe.

Williamsport Group

Donald E. Dahlberg.

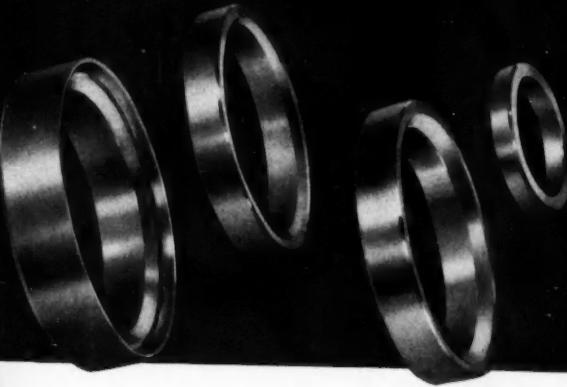
Outside of Section Territory

George H. Aitken, Eduardo Velazquez Chavez, Delwin E. Cobb, V. R. Geissler, Seaton Moon, Jr., George Milton Savage, Patrick Gerald Tobin.

Foreign

James Walter Agnew Andrews, Nigeria; Lauro Xavier Nepomuceno, Brazil; Franco Pinolini, Italy; Carlo Pollone, Italy; Bernard Arthur Barrow, New Zealand.

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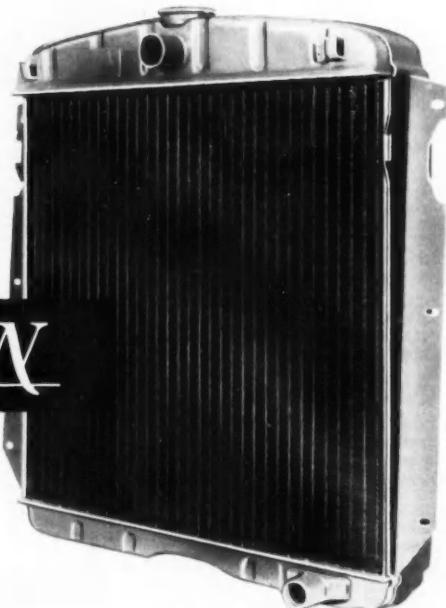


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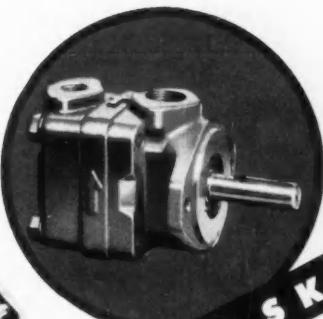
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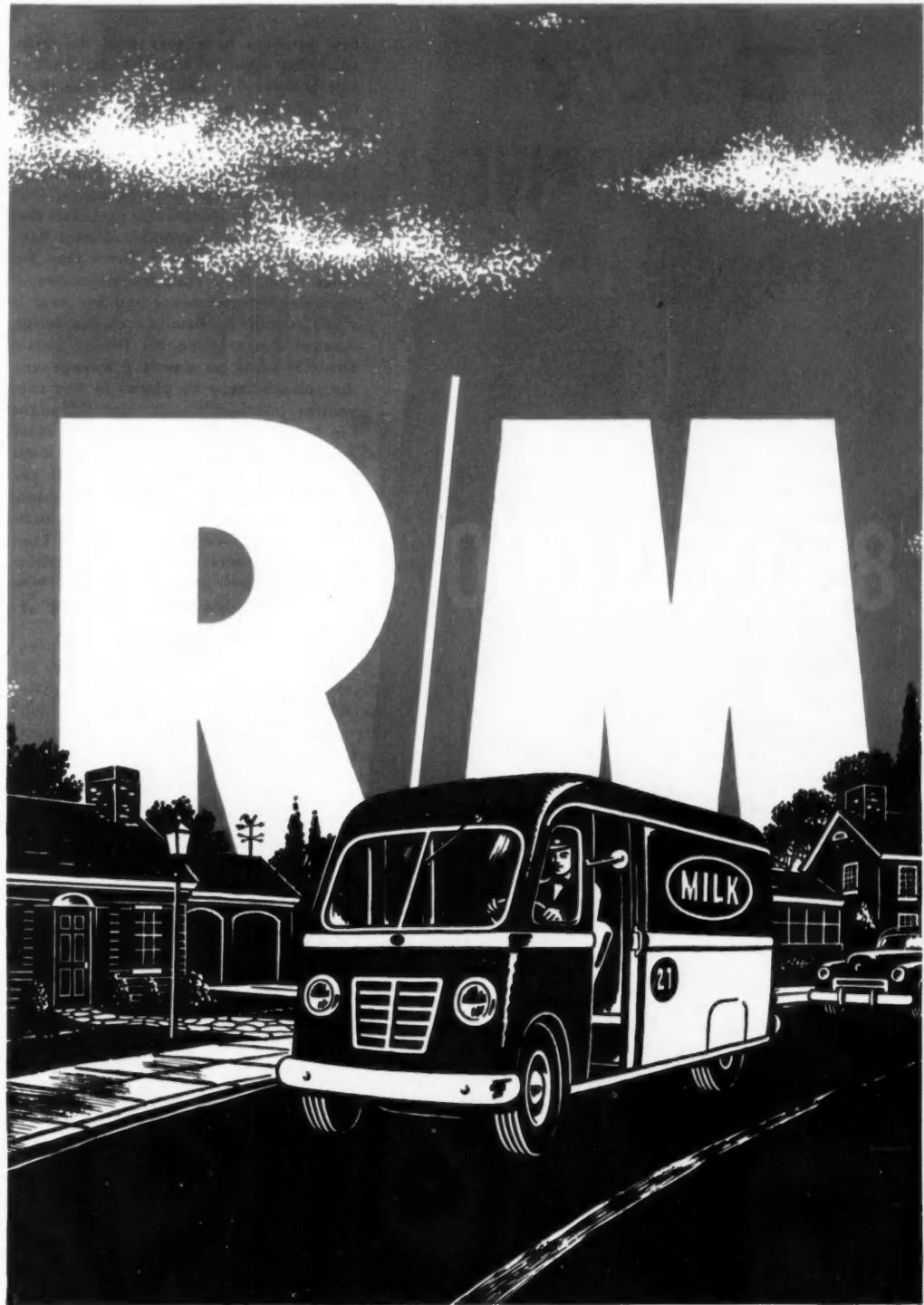
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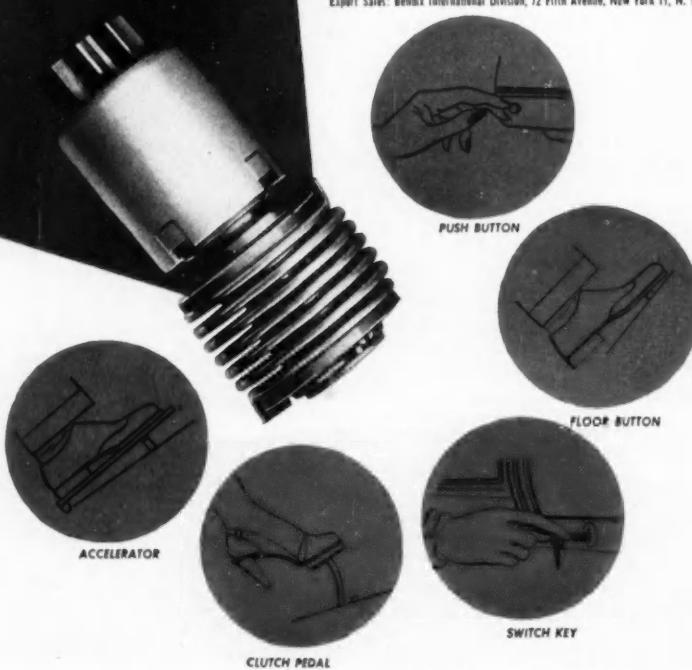


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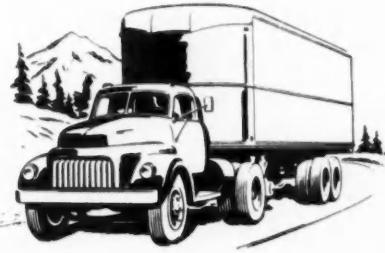
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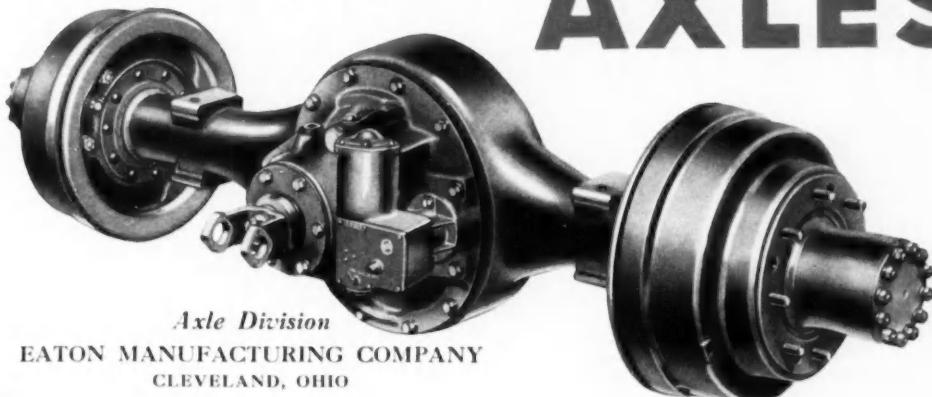
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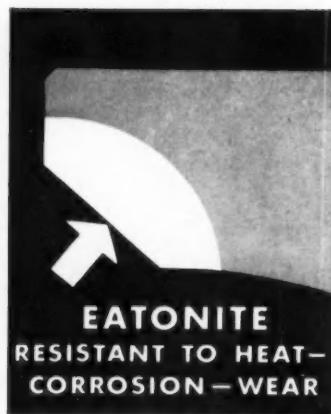
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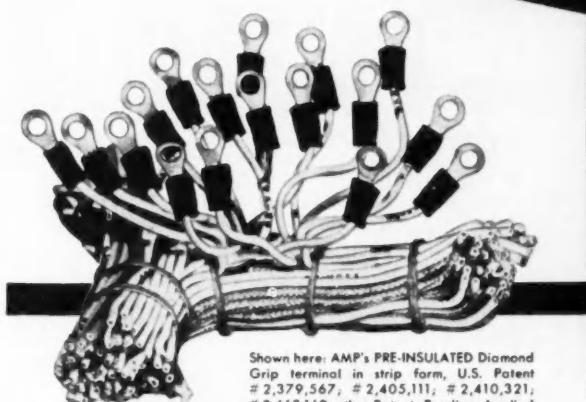
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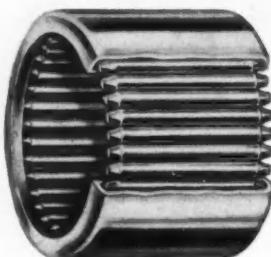
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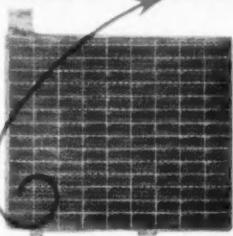


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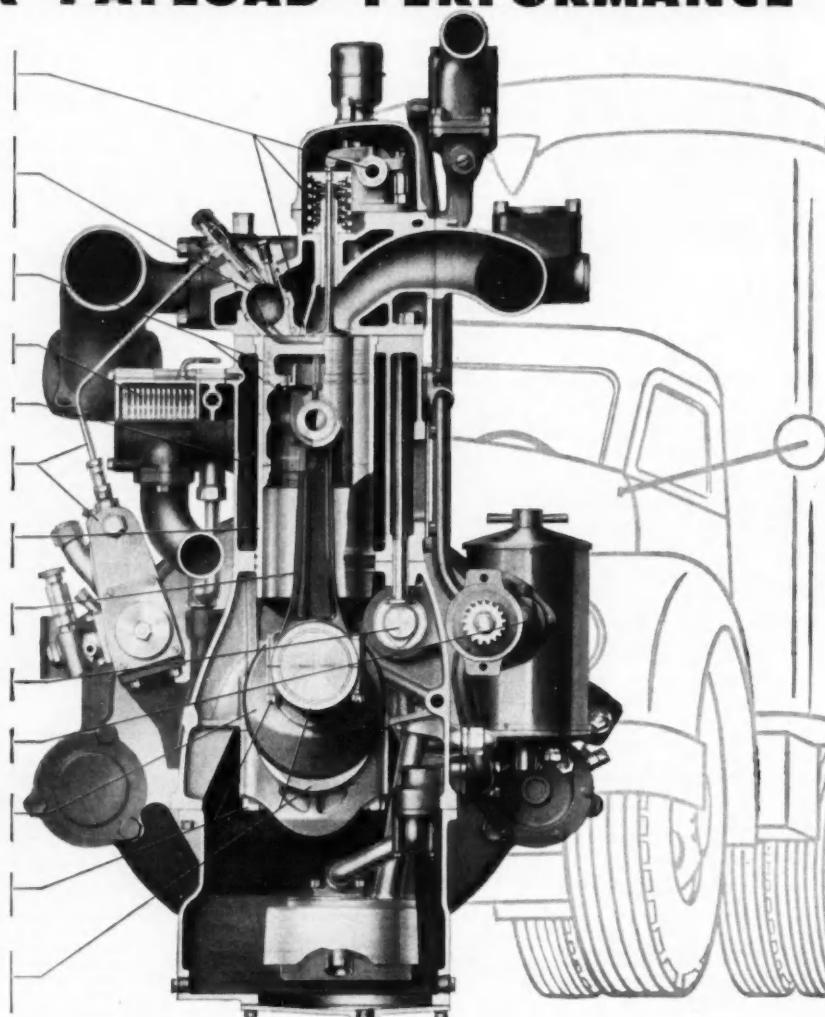
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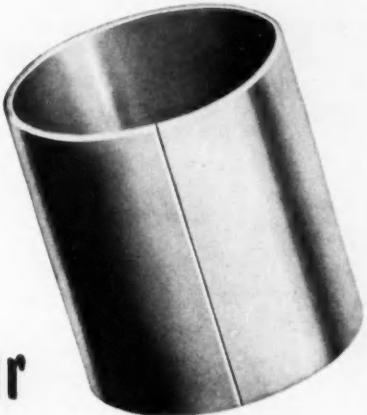
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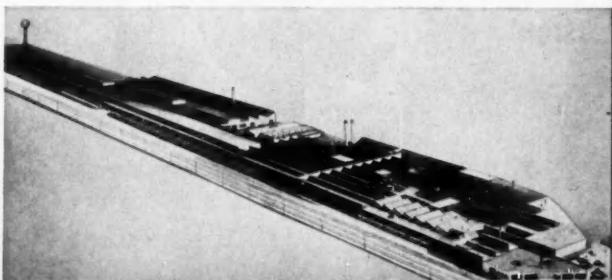


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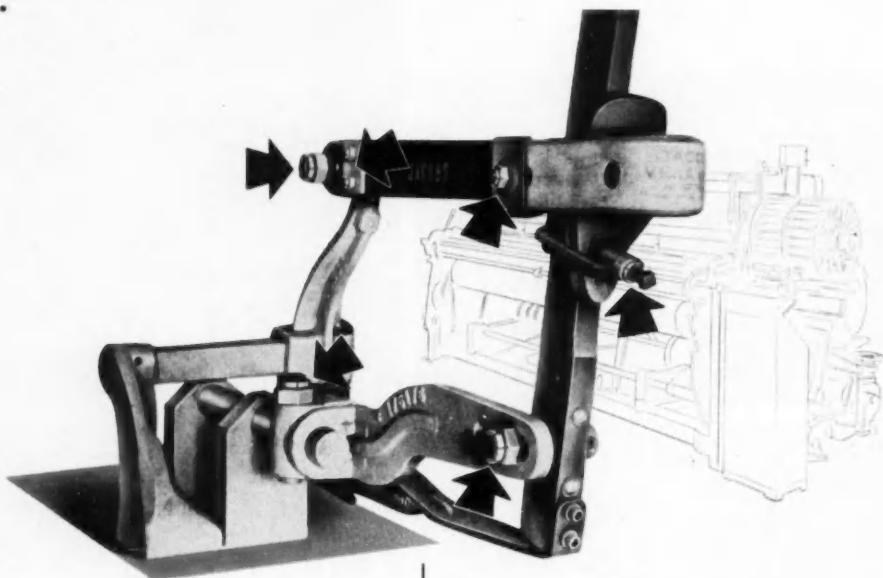
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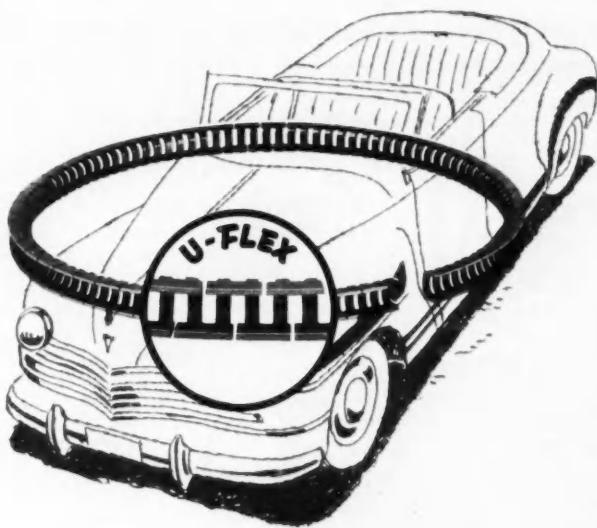
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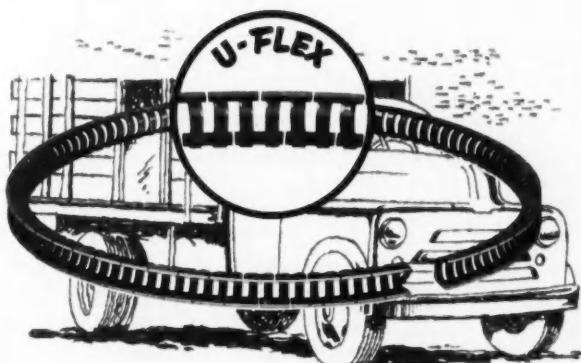
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A PISTON RING to satisfy any oil control problem . . . that's Thompson's U-FLEX OIL CONTROL PISTON RING—used as original equipment by many car and truck manufacturers. Look at it closely. You'll find:

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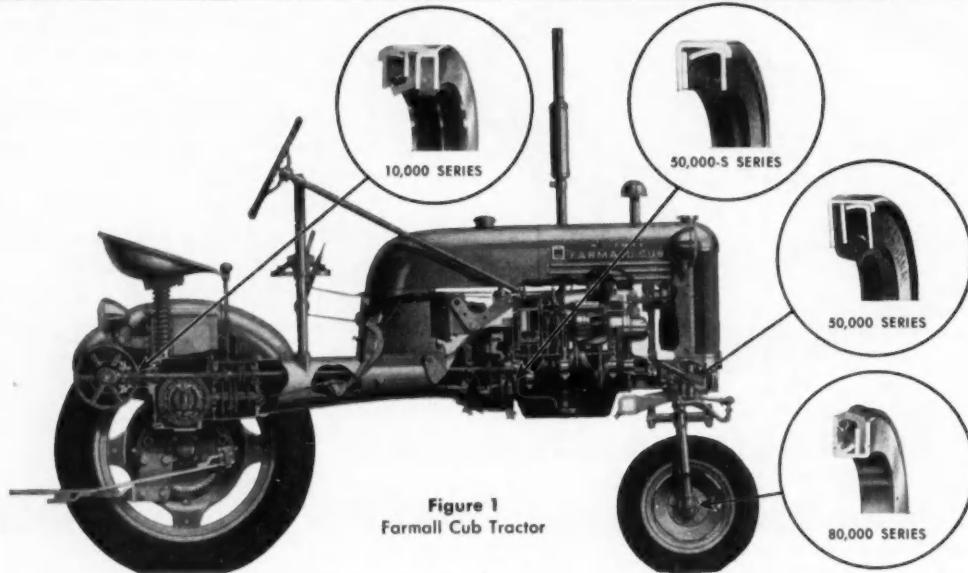


Figure 1
Farmall Cub Tractor

International Harvester uses oil seals extensively to help insure dependable performance in Farmall Cub tractor

The design of agricultural equipment must provide for utmost dependability despite hard knocks in service and unpredictable maintenance by the user. In the compact Farmall Cub tractor, International Harvester uses oil seals at many vital points to assure a maximum of mechanical reliability.

Several different sealing problems are present in the Cub (Figure 1). On the front wheel shaft, heavy accumulations of dirt and dust must be excluded while grease is retained around the bearing. A spring-loaded external seal with a sturdy leather sealing member (National 80,000 series) is used. On the steering shaft, dirt accumulation is less severe, but there is oscillating shaft movement. A conventional spring-loaded leather seal (National 50,000

series) meets this problem and retains gear grease.

At the rear crankshaft bearing, operating temperatures are higher; so National Syntech* (50,000-S series) are used. These seals are ideal for this application since their synthetic rubber sealing members are capable of withstanding intermittent temperatures up to 300° F.

On the power take-off assembly, dust exclusion is a big problem along with lubricant retention; so a dual seal with one leather and one felt sealing lip is used (National 10,000 series). On the rear wheels and the transmission spline shaft, seals are encased in a housing and the principal problem is lubricant retention. Here effective sealing is obtained with spring-loaded leather seals

in a special case to simplify mounting. Each sealing problem in the Farmall Cub is met with a different type of seal. However, the majority of seals used are of standard design and are thus readily available with a minimum of tooling cost. Many sealing problems can be solved economically with standard design seals; other applications require special seals to meet special problems. In either case, National Oil Seal engineers can apply 30 years of experience to the problem.

"Let Your Decision be Based on Precision"



NATIONAL MOTOR BEARING CO., INC.

General Offices: Redwood City, California
Plants: Redwood City, Calif.; Downey (Los Angeles County), Calif.; Van Wert, Ohio

2383

* Trade Mark Registered

CALL IN A NATIONAL FIELD ENGINEER

BUFFALO, N. Y.	Room 1124, Prudential Bldg., Mohawk 9222	NEW YORK CITY, N. Y.	122 East 42nd Street, Murray Hill 6-0171
CHICAGO, ILL.	Room 4113 Field Building, Franklin 2-2847	PHILADELPHIA, PA.	401 North Broad Street, Bell-Walnut 2-6997
CLEVELAND, OHIO	210 Heights Rockefeller Bldg., Yellowstone 2-2720	REDWOOD CITY, CALIF.	Broadway and National, Emerson 6-3861
DALLAS, TEXAS	30½ Highland Park Village, Justin 8-8453	RICHMOND, VA.	216 South Fifth Street, Richmond 2-5476
DETROIT, MICH.	726 Lothrop Avenue, Trinity 1-6363	ROCHESTER, N. Y.	95 Landing Road, Culver 3531
DOWNNEY (Los Angeles Co.), CALIF.	11634 Patten Rd., Topaz 2-8166	WEST SPRINGFIELD, MASS.	1025 Elm Street, Springfield 2-1881
MILWAUKEE, WIS.	647 West Virginia Street, Broadway 1-3234	SYRACUSE, N. Y.	P.O. Box 1224, Baldwinsville 662
	WICHITA, KANSAS		519 South Broadway, Wichita 2-6971

Springs by Eaton



Eaton Leaf and Coil Springs
Incorporate a Number of
Exclusive Eaton Quality
Developments

MORE than twenty makes of passenger cars and trucks are equipped with Eaton chassis springs—engineered for proper suspension and easy riding, skillfully heat-treated to assure long life. One of many Eaton advancements in leaf spring design and production is the use of grooved

section steel, which with the same moment of inertia, effects a saving of ten per cent in weight. Added life is given to Eaton springs, both leaf and coil, by "peeling," a patented Eaton-developed process of uniformly cold-working the critical spring surfaces by controlled shot-peening.

EATON MANUFACTURING COMPANY

GENERAL OFFICES: CLEVELAND, OHIO

SPRING DIVISION: 9771 FRENCH ROAD • DETROIT 13, MICHIGAN

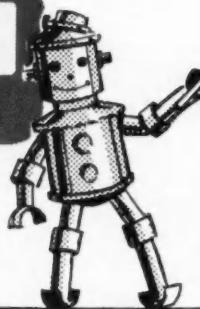


PRODUCTS: Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater-Defroster Units • Snap Rings • Springtites • Spring Washers • Cold Drawn Steel • Stampings • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers

HIGHLIGHTS OF 1951 ANNUAL REPORT

CGB

**The Cleveland
Graphite Bronze
Company**



	1951	1950
Sales and other revenues . . .	\$50,052,126	\$42,506,042
Profit	2,887,826	3,914,228
Percent of profit to sales and other revenues . . .	5.7%	9.2%
Taxes	\$5,280,810	\$4,376,677
Per common share:		
Profit	\$4.05	\$5.75
Taxes on income	7.19	5.99
Dividends	2.30	2.60
Floor space in use and under construction (square feet)	1,641,000	1,114,000
Number of plants	11	7
Employees (year-end)	4,527	4,095
Common shareholders (year-end)	3,689	3,208

In 1951 we did more business than in any other year in our history except 1944. The profit after all expenses and charges was \$2,887,826. After payment of \$1,533,435 in dividends on common stock (\$2.30 per share) and \$182,855 on preferred stock, the remainder of \$1,171,536 was retained in the business.

SALES AND PRODUCTION—Although the automobile industry produced but 6,750,000 cars and trucks as against 8,020,000 the year before, we supplied about the same volume of bearings and bushings as in 1950.

Important gains were made in our production for the national defense program, in bearings for Diesel railroad locomotives, and in bushings. Our Replacement Sales business and our subsidiary companies, Harris Products Company and Clevite Limited (Canada) also achieved sales increases.

It appears that motor car production in 1952 will continue to be restricted—possibly to about 4,000,000 passenger cars and 1,000,000 trucks—but we are expecting to maintain a high overall volume by increases in defense work, in Diesel bearings, in sales to the automotive replacement market, and in the operations of our subsidiaries.

NEW PLANTS—Our new plant at Caldwell, Ohio, has been in production of bushings since November, although some equipment is yet to be installed. At McConnelsville, Ohio, we are about to start production of aircraft engine bearings. The new plant at St. Thomas, Ontario should be ready for Clevite Ltd. to transfer operations from the old plant in April.

NEW PRODUCTS—Several years ago we brought out with great success our "Micro" bearing for automobile engines, using a thinner bearing layer than had ever been attempted before. In 1951 we developed a super-Micro bearing with a bearing layer only half as thick as in the original Micro. The new bearing is now standard in several of the latest and most advanced engines and performs successfully where otherwise a costlier bearing would be required.

After several years of research we can report that we are now turning out some products using aluminum as a bearing surface. This development is potentially important, not only for its insurance value when other metals are scarce, but

because it adds a new family of alloys which could lead toward products we have never made before.

BRUSH DEVELOPMENT COMPANY—We have recently acquired all of the outstanding stock of The Brush Development Company in exchange for shares of our common and preferred stock.

Brush Development manufactures various products used in recording and reproducing sound, including crystals, hearing aid microphones and earphones, industrial instruments, and magnetic sound recorders.

Through this transaction we are obtaining an established and profitable position in the rapidly-growing field of electronics, including several projects of importance in the defense program. Brush has under way additional products which may become significant in the defense program and hold broad possibilities for civilian business as well. We also secure the services of a seasoned group of research scientists who should materially assist in advancing our lines as well as those of Brush.

Brush should correspondingly benefit by sharing in our ability in mass precision manufacturing, our wider experience in financial and cost control and component marketing, and our strong financial resources.

OUTLOOK—We are expecting a volume of business in 1952 moderately higher than in 1951, without counting the sales volume of Brush Development Company. Some of the costs which arose last year in connection with the national defense program and its early dislocations should be avoided in 1952, and we are also planning to make new cost reductions through operating improvements. We thus hope to safeguard, and perhaps improve, the smaller profit margins left to us after paying today's unprecedented peacetime taxes.

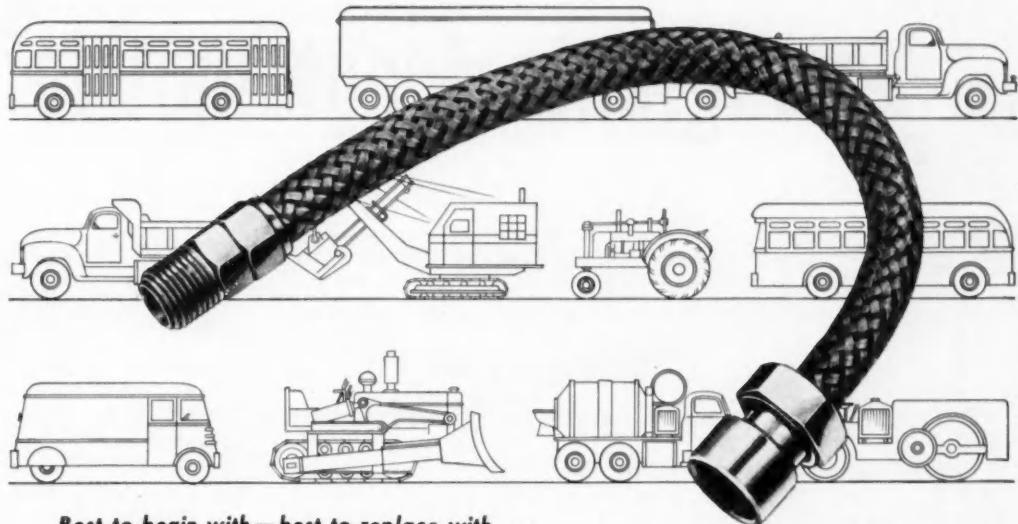
BEN F. HOPKINS
Chairman

JAMES L. MYERS
President

General Offices and Factory: 17000 St. Clair Avenue, Cleveland 10, Ohio

Branch and Subsidiary Plants at Cleveland, Milan, Bridgeport, Caldwell and McConnelsville, Ohio; Ft. Wayne, Indiana and St. Thomas, Ontario

A COPY OF THE 1951 ANNUAL REPORT WILL BE SENT UPON REQUEST



Best to begin with—best to replace with...

TITEFLEX® Flexible all-metal hose

Want to cut maintenance and replacement costs of gasoline, oil, water and air lines?

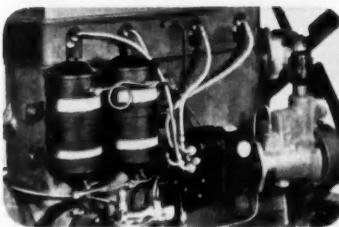
Replace those on your present equipment with TITEFLEX Flexible All-Metal Hose. And be sure your new equipment is fitted with TITEFLEX. You'll save money.

Reason: TITEFLEX does not crack, bake or deteriorate even when exposed to high engine temperatures. Gas, oil and other liquids have no effect on it. Yet TITEFLEX is fully flexible and withstands excessive vibration over long periods.

Longer service life actually makes TITEFLEX less costly than synthetics, rubber or fabric-packed hose. Our design and engineering staff will be glad to help you with your flexible tubing problems. Get the full story today. Send coupon for TITEFLEX literature—without obligation. Check off TITEFLEX ignition shielding, too, if you're having interference trouble.



Titeflex flexible metal hose fuel line to engine on a milk delivery truck. Operator's entire fleet of 76 trucks is Titeflex-equipped.



Titeflex Automotive Ignition Shielding Leads for the engine of a Le Roi Model 210G 2-Stage Portable air compressor.

Let Our Family of Products Help Yours

✓ Check products you are interested in.



SEAMED AND
SEAMLESS METAL HOSE



PRECISION BELLOWS



IGNITION HARNESS



IGNITION SHIELDING



ELECTRICAL
CONNECTORS



RIGID AND FLEXIBLE
WAVE GUIDES



FILTERS



FUSES

Titeflex

TITEFLEX, INC.
526 Frelinghuysen Ave.
Newark 5, N.J.

Please send me without cost
information about the products
checked at the left.

NAME _____

TITLE _____

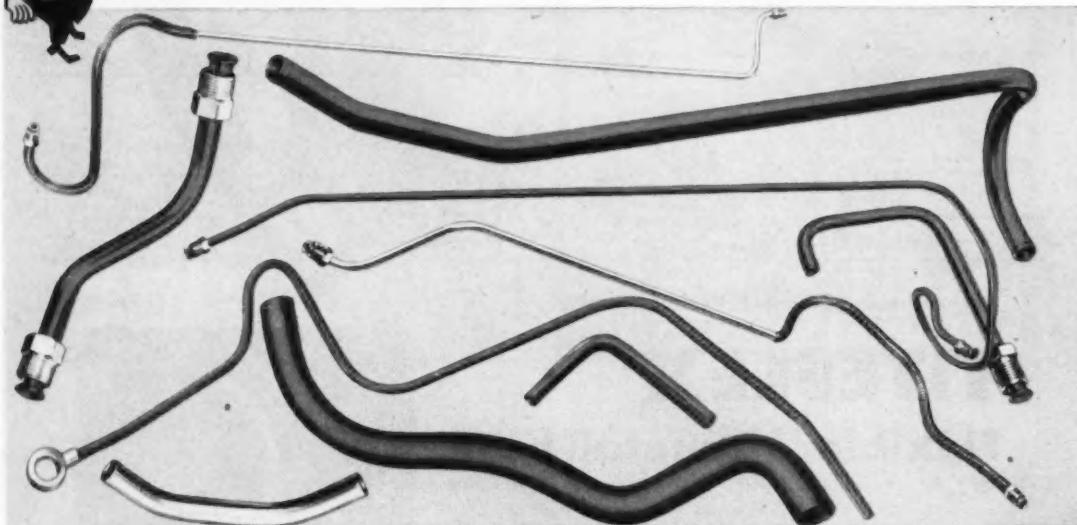
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CITY _____ ZONE _____ STATE _____



Your greatest automotive

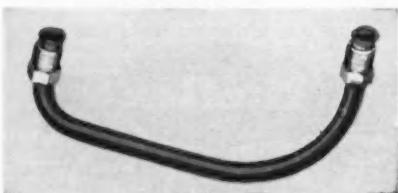


FABRICATION SAVINGS



COSTS CUT

You save in the constant search for lowered production costs on your specific automotive part at Bundy. Fabricating the bead and bend in oil level indicator above formerly required two separate operations. Now the two are combined in one Bundy-engineered step, and costs of unit reduced accordingly.



PRODUCTION SAVINGS

You save in the continual improvement of basic production steps within Bundy, as well. Assembly of flare nuts in end-to-end alignment on tubing lengths, as above, formerly a tedious hand operation, is now expedited by Bundy-developed automatic nut assembler. Savings go right on to Bundy customers.

Shooting for lowered manufacturing costs, better automotive performance in your new designs? Bundy engineers can help work out the easiest, most practical ways to fabricate new lines and tubing parts in double-walled Bundyweld. Often make substantial extra savings by showing how to use less tubing, where to take production short-cuts. You save because Bundy men "can do!"



PERFORMANCE SAVINGS

You save, too, with Bundyweld's dependable, trouble-free, safe performance the life of your automotive equipment. Sturdy, more resistant to failure from vibration, extra-rugged and strong, Bundyweld is used in the fuel, oil and brake-line systems of 95% of today's cars . . . evidence of its dependability.

tubing buy on every count

Tubing features second to none, priceless, time-proved, safe performance, plus engineering skills that cut costs to the bone, yours when you specify Bundyweld Tubing

When specifying tubing for brake lines and other automotive applications, look beyond the question of cost-per-foot. Look at all that you buy in Bundyweld Tubing.

In the last 20 years, 360,000 miles of Bundyweld Tubing have been used in the brake-line systems of cars, trucks, tractors and buses in all price ranges. You buy safety, proved in the billions of miles traveled by these vehicles.

Here is the only tubing double-walled from a single strip, copper-bonded through 360° of wall contact. No other tubing has all of Bundyweld's features because of this one-of-a-kind design. Bundyweld is extra-sturdy and -strong, highly resistant to brutal shock and vibration fatigue.

You buy the world's finest automotive tubing, feature-wise.

Bundyweld hits your assembly lines clean as a whistle inside and out...as specified, and on time. Either prefabricated by Bundy, or in lightweight, easy-handling lengths ready for fast, economical fabrication by your men. In fabrication, in deliveries, you buy unsurpassed engineering skills and services that mean savings in the long run.

Price-conscious, or performance-conscious—or both—the world's finest automotive engineers know there is no adequate substitute for Bundyweld Tubing.

There can't be. No other tubing is like it.

Contact a Bundyweld Distributor listed below, or write direct to Bundy Tubing Company, Detroit 14, Michigan

Bundyweld Tubing®

DOUBLE-WALLED FROM A SINGLE STRIP



WHY BUNDYWELD IS BETTER TUBING



Bundyweld starts as a single strip of basic metal, coated with a bonding metal. Then it's . . .



continuously rolled twice around laterally into a tube of uniform thickness, and



passed through a furnace. Bonding metal fuses with basic metal, presto—



Bundyweld double-walled and brazed through 360° of wall contact.



Chattanooga 2, Tenn.: Pearson-Deakins Co., 823-824 Chattanooga
Bank Bldg. • Chicago 32, Ill.: Lapham-Hickey Co., 3333 W. 47th Place • Elizabeth, New Jersey: A. B. Murray Co., Inc., Post Office Box 476
Rutan & Co., 1717 Sansom St. • San Francisco 10, Calif.: Pacific Metals Co., Ltd., 3100 19th St. • Seattle 4, Wash.: Eagle Metals Co., 4755 First Ave. South

Bundyweld nickel and Monel tubing is sold by distributors of nickel and nickel alloys in principal cities.

NOTE the exclusive patented Bundyweld beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.

The BENDIX IGNITION ANALYZER Checks More Plugs Faster!



Result: TIME-SAVING

KEEPS PLANES ON SCHEDULE BY ELIMINATING HIT AND MISS TROUBLE SHOOTING

Even before the wheels touch the runway, the ignition fault has been pin-pointed and a maintenance crew stands by to make a fast repair. Minutes later the ship departs on *schedule*. The fast, certain repair job was possible because the trouble shooting was done in flight, by the operator of a Bendix Ignition Analyzer. While making a routine check of several plugs the scope reading showed a trouble pattern. The operator quickly analyzed the location and seriousness of the trouble and the word was radioed ahead. Meanwhile, the pilot reduced power of the malfunctioning engine to cool it in flight and ready it for maintenance. Just such a case as this is the reason why one airline has reduced turn-around time by 18% with the Bendix Ignition Analyzer. It can do the same for you and much more besides.

*Write us for free literature concerning
the Bendix Ignition Analyzer.*



Costs Less—Does More

The Bendix Ignition Analyzer is available for either airborne or portable-airborne installations. It can be used with either high or low tension magneto or battery ignition. It is the ignition analyzer that can predict spark plug failure before it occurs . . . make an efficient check of more than one spark plug at a time and do so on a large, easy to read screen . . . yet it costs less than comparable analyzers.



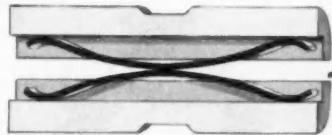
SCINTILLA MAGNETO DIVISION OF
SIDNEY, NEW YORK



Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.

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CLARK ANNOUNCES THE Split-Pin Synchronizer

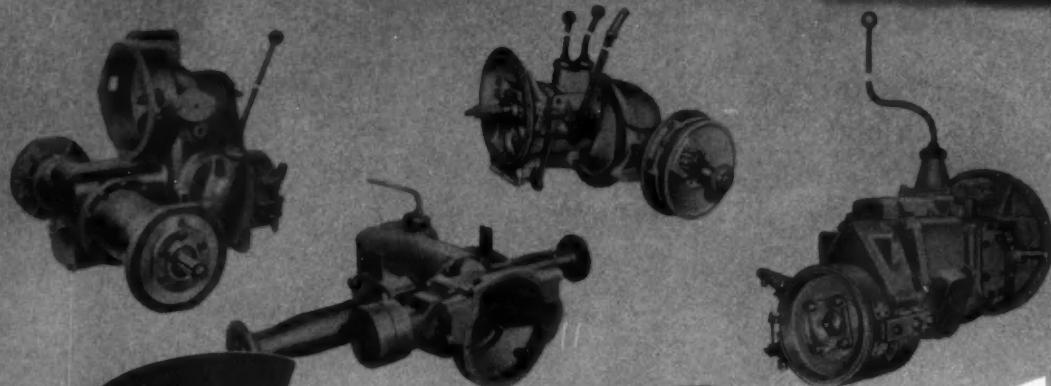


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SIMPLICITY
RUGGEDNESS
DEPENDABILITY

CLARK EQUIPMENT COMPANY

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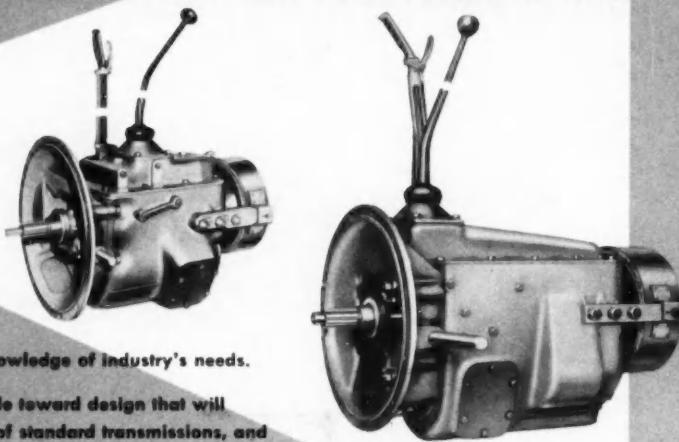
FOR
MORE
ABOUT
CLARK
EQUIPMENT
TURN
THE
PAGE



CLARK Transmissions

The "Split-Pin" Synchronizers are now in these two Clark transmissions now available—what is not new is the Clark enthusiasm for engineering research, combined with the practical knowledge of industry's needs.

It is this traditional Clark attitude toward design that will continue to produce a full line of standard transmissions, and continue to tackle and solve special problems involving unusual transmission requirements . . . for trucks, buses, farm tractors, industrial trucks, and road building machines.



Products of Clark - TRANSMISSIONS



AXLE HOUSINGS

FORK TRUCKS & TOWING TRACTORS



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FRONT & REAR AXLES FOR TRUCKS & BUSES



TRACTOR UNITS





This emblem symbolizes the fundamental strength behind the seven modern Dee-Gee plants—producing a wide range of industrial products. • Long famous for highest quality gaskets, Dee-Gee also meets the most exacting demands for fabricated parts, glazing tapes, dash insulators, sun visors and glove compartments, aluminum extrusions and brass rods. • Complete research and engineering departments are available at all times to assist with your production problems.

DETROIT GASKET & MANUFACTURING COMPANY
DETROIT 23, MICHIGAN



*Cut it Better-Faster-Cheaper
with*

CARMET

Carbide Tools

*What other
jobs have you
for CARMET
to do*

We specialize in precision pre-forming of Carmet carbide metals to *any* shape for special wear-resistance needs, such as dies, gage blanks, etc. Let us quote on your requirements.

The Allegheny Ludlum line of Carmet Carbide Tools is *complete*—every style, size and grade you may need for any cutting job in the shop. If you make your own tools, a full line of blanks is available, too—as well as all necessary sizes of A-L Shank Steel. Extensive stocks of Carmet standard tools and blanks are carried in A-L and Distributor's warehouses coast to coast, and special tools are available to order. • Just remember, for best performance on any application, use *Carmet*!



Allegheny Ludlum Steel Corporation

CARMET DIVISION, Detroit 20, Michigan

DISTRIBUTORS: Write us about handling CARMET Standard Tools in your territory.



to move more, faster... *hp.*

The formula for moving any load at higher average speeds, *for less*, is simple:

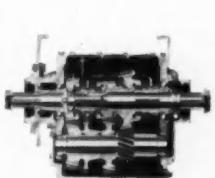
Put your horsepower to work *effectively*.

Every time you lug your engine, or even let it drop below the maximum efficiency range, you lose profits.

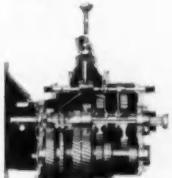
That's why the *right* transmission for your "road and load" is so important. That's why so many profit-wise operators specify Fuller Heavy-Duty Transmissions, Fuller Auxiliary Transmissions—and Fuller 10-Speed ROAD RANGER® Transmissions.

For the transmission is where *horsepower goes to work*. And Fuller has proved, time and again, to owner, to mechanic and to driver that Fuller Transmissions gear your rig to use more of your horsepower—to move more, faster, for less.

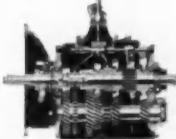
Illustrated are four of the wide selection of Fuller Heavy-Duty Transmissions. Ask for data on the type and hp range in which you are interested.



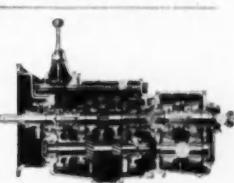
3-A-65



5-A-620



5-C-720



10-B-1120

FULLER MANUFACTURING COMPANY (Transmission Division), KALAMAZOO 13F, MICHIGAN

Unit Drop Forge Division, Milwaukee 1, Wis. • WESTERN DISTRICT OFFICE (SALES & SERVICE—BOTH DIVISIONS), 1060 E. 11th Street, Oakland 6, Calif.



Announcing
Alcoa Aluminum
tinting paste
no. 222

For Metallic Finishes
That Have:

- More Glamour
- Maximum Two-Tone
- Greater Depth
- Gloss Retention
- No Seeding
- Richer Color Values



ALCOA First in Aluminum

NOW 6:30 P.M. EDST every Sunday—"SEE IT NOW" with Edward R. Murrow . . . brings the world to your armchair . . . CBS Television

You may be noticing new richness and sparkle in the polychrome finishes of some of the new automobiles. When you do, you will be viewing another example of Alcoa's co-operative work with its paint manufacturing customers.

In a two-year search, we looked for a way to produce an aluminum tinting paste that essentially was of uniform particle size in the middle or true glamour range. Required were: freedom from oversized flakes that might cause seeding; absence of extreme fines that cloud and spoil true color values; retention of gloss, improved two-tone and glamour, and all other properties that characterize a good Metallic.

After 196 experimental batches, we found the answer. It is available to all paint manufacturers as Alcoa Aluminum Tinting Paste No. 222.

The experience and facilities which developed Albron 222 are available to assist you in furthering the application of aluminum's advantages to automotive uses. Whatever phase of your company's activities is your responsibility, you'll find an Alcoa specialist who talks your language. Call your Alcoa sales engineer for complete details of the facilities of Alcoa's Research and Development Divisions. Or write:

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1844-G Gulf Building • Pittsburgh 19, Pennsylvania

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And it sounds good to the many dealers who are now using Certified Air Service as part of their regular procedures . . . and it helps them service and sell tires. This is but one example of the service behind Schrader Tire Valve Equipment that extends right down to the car owner.

Have you seen a copy of the Certified Air Service procedure manual? Write for Manual C-200.

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Division of Scovill Manufacturing Company, Incorporated

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FIRST NAME IN TIRE VALVES

FOR ORIGINAL EQUIPMENT AND REPLACEMENT



Heavy Duty...

Long Clutches mean Dependability!

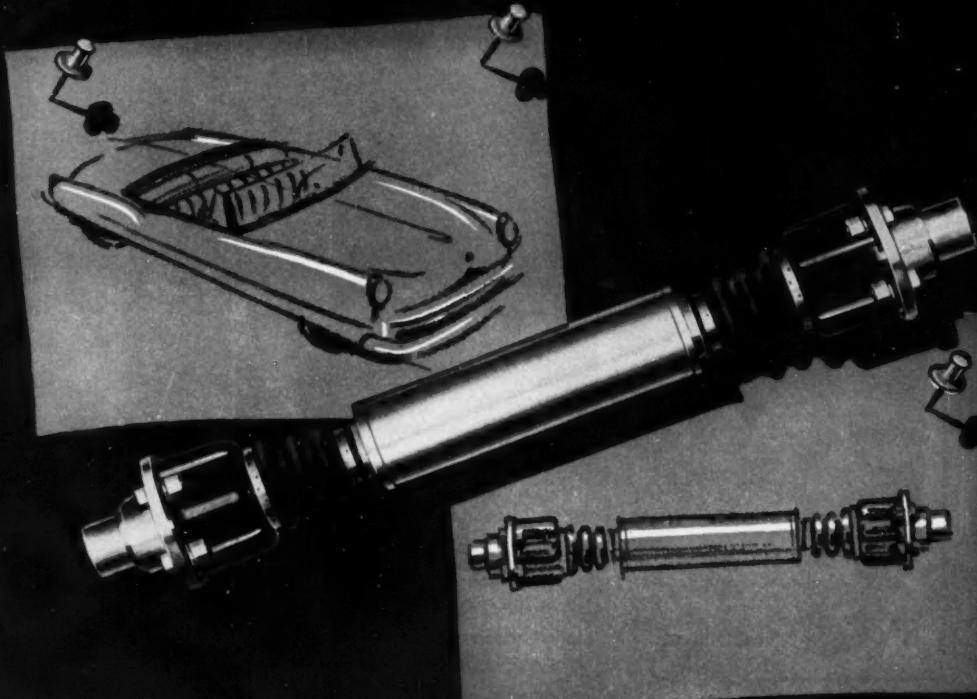
Rugged, durable Long clutches have met the heavy-duty requirements of vehicle manufacturers since 1922.

From our wide range of clutch sizes and capacities, we have equipped millions of cars, trucks, buses, tractors and military vehicles.

LONG MANUFACTURING DIVISION
Borg-Warner Corporation
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DETROIT UNIVERSAL JOINTS
• *the Original Equipment Line* •
Keep Pace with Car Design



Detroit's Exclusive Anti-Friction Slip Motion
Assures a Better Riding Car

Increased speed and torque of high compression engines
place additional burdens on universal joints. DETROIT
Universals are keeping pace with these requirements.

Detroit **UNIVERSAL JOINTS**



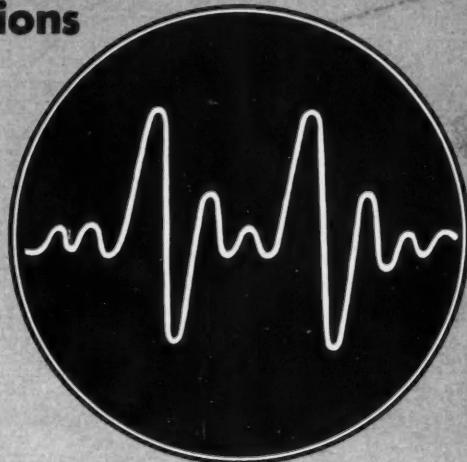
UNIVERSAL PRODUCTS COMPANY, Inc., Dearborn, Michigan

**NOW... GET DIRECT READINGS of
Average and Instantaneous Angular Velocity
and Torsional Oscillations**

with the

ROTALYZER

Model WB



An electronic tachometer of very high angular resolution for accurate measurements of average and instantaneous angular velocity (RPM). Average RPM is measured by accurate electronic comparison method, and indicated directly on panel. Instantaneous RPM vs. time is displayed on calibrated screen of cathode-ray oscilloscope, or may be recorded on a suitable recording oscilloscope. Easily adapted to recording device to produce recording tachometer. High angular resolution allows use for analysis of

systems in which several periods of the variation in RPM exist during one revolution.

The ROTALYZER is designed for work on systems with average RPMs varying between 500 and 9000 RPM, and will faithfully indicate instantaneous variations of any amplitude within this range, where these variations occur at rates between 0 and 500 per second. These ranges can be extended, if necessary.

Tachometer pickup head of very low inertia supplied — approximately 80 gram-cm².

Typical applications: Reciprocating and rotating internal combustion engines; as transducer in Rate Servo system; machine tool vibration analysis; study of hunting in automatic control systems, etc.

Price: \$1950.00 f.o.b. factory, complete with Tachometer Pickup, Electronic Analyzer Unit, Oscillograph Indicator (a specially modified DuMont 304H Oscillograph).

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FACS
ORDNANCE
APPROVED
FOR GOVERNMENT USE

A dependable new source TO HELP YOU
SOLVE YOUR SPECIALIZED ELECTRICAL PROBLEMS
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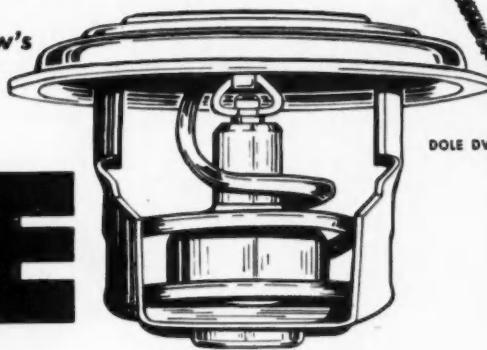


PRODUCTS, INC. 18 EAST 18TH STREET, CHICAGO 16, ILLINOIS

Foremost with Accurate Connector Systems

Plus Performance

for temperature control
of engines with pressurized
cooling systems: for
today's and tomorrow's
cars and trucks



DOLE "DV" Thermostats

DOLE DV THERMOSTATS used in leading makes — have proved their dependability and capacity to operate positively against the higher pump pressures in modern sealed cooling systems.

DOLE DV THERMOSTATS are also more efficient for the modern cars with open cooling systems.

In a word, DOLE DV THERMOSTATS help *all* cars of advanced design to give top performance—quick warm-up, savings of gasoline, oil and motor wear. Plus, of course, quick heat from the car heater.

Dole Thermostats are available in various sizes and models to meet all installation requirements.



DOLE DV 1



DOLE DV 2



DOLE DV 3

CONTROL WITH DOLE

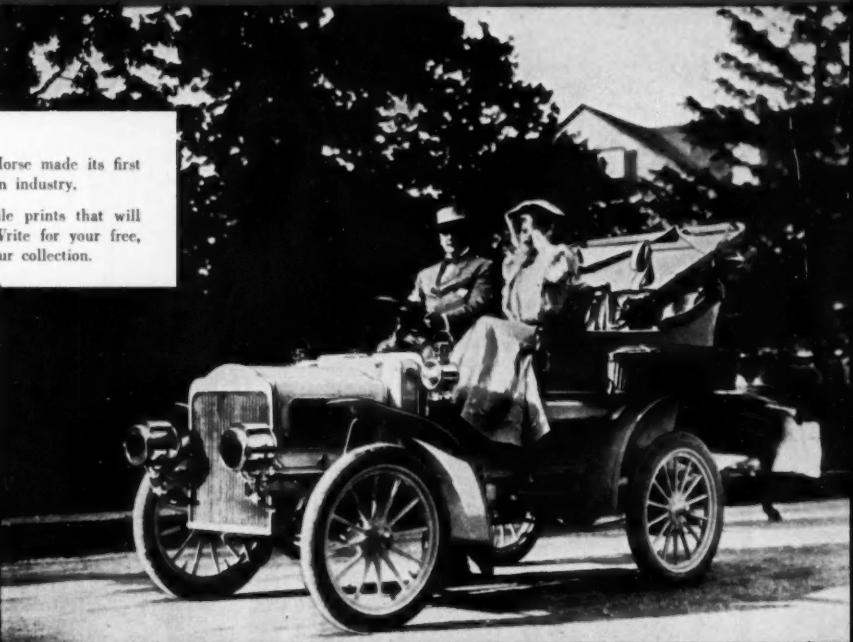
THE DOLE VALVE COMPANY • 1901-1941 Carroll Avenue, Chicago 12, Illinois • Detroit • Los Angeles • Philadelphia

From the Detroit Archives

Send for free print.

White Steam Car, 1905—16 years after Morse made its first precision-built chains for the transportation industry.

This is one of a series of old automobile prints that will appear in future Morse advertisements. Write for your free, enlarged copy, suitable for framing for your collection.

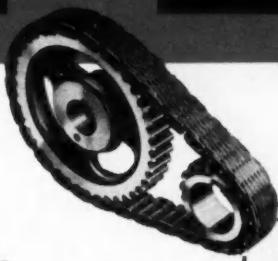


To the automotive industry

M = TC
Morse means Timing Chains

There are many reasons why Morse is the leading producer of automotive timing chain drives.

Pictured at right is one reason.



There are over 54 million others.

To the automotive industry, naturally enough,
M = TC; Morse means Timing Chains.

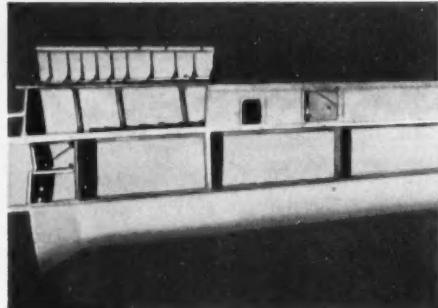
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PRODUCTS
PRODUCTS OF
BW
BORG-WARNER

better
wings

*can be
made
with*

MAGNESIUM



Problems of critical weight, increased torsional rigidity, and simplified design can often be solved by using magnesium.

In the design of high-speed wings, for instance, the use of a thick skin . . . made possible with magnesium . . . offers many advantages. Illustrated at left is a complete fighter plane wing made with magnesium. Note the simplified construction. Although this wing, ready for flight, weighs no more than a conventional wing, *torsional rigidity has been increased 50%!* By using a thick magnesium skin, all spanwise stringers and half the ribs were eliminated, reducing the number of parts 69%, the number of fastenings 62%, and adding fuel capacity that increased the plane's range 18%!

Wherever the combination of strength and light weight are a design necessity, look at magnesium. Recent technical advances in alloying, fabricating and finishing have made magnesium a leading metal for aircraft construction.

THE DOW CHEMICAL COMPANY

Magnesium Department • Midland, Michigan

New York • Boston • Philadelphia • Atlanta • Cleveland • Detroit
Chicago • St. Louis • Houston • San Francisco • Los Angeles • Seattle
Dow Chemical of Canada, Limited, Toronto, Canada

DOW

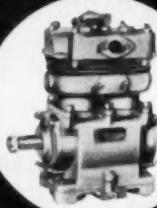


SAE JOURNAL, JULY, 1952

**Bendix
Westinghouse**
THE WORLD'S MOST TRIED
AND TRUSTED
AIR BRAKES

Feature for Feature.....

**the Finest Complete
Braking System
money can build or buy!**



The Bendix-Westinghouse Compressor—heart of the air brake system—performance proven over more miles on more installations than any other compressor available!



The Bendix-Westinghouse Brake Valve—main control of the system—unsurpassed for fine graduation and perfect control under all braking situations on any size vehicle.



The Bendix-Westinghouse Governor—hard-working watchman of the system—provides unexcelled assurance of adequate air pressure at all times to meet every braking need.

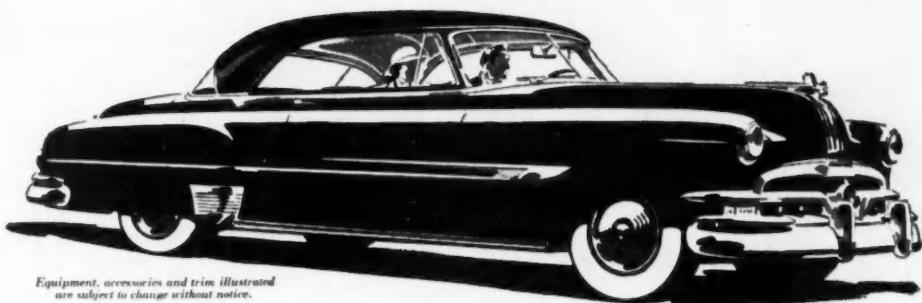


If you want a full 100% return on every dollar you invest in braking, it will pay you many times over to specify Bendix-Westinghouse Air Brakes for your trucks and buses. Why? Because only a complete braking system can give your vehicles the kind of performance that means highest operating efficiency at lowest operating cost. And with Bendix-Westinghouse you get the finest complete braking system money can build or buy! That's because each and every component part in the Bendix-Westinghouse system is designed to perform a specific function and to perform it better than any other make or model. For example, the rugged Bendix-Westinghouse compressor is noted for its long, reliable, trouble-free service; the brake valve for its greater capacity, finer graduation, faster application and release; the governor, for its extra dependability and ease of maintenance due to its mounting position away from high engine temperatures and excessive vibration. Put them all together with rugged Bendix-Westinghouse brake chambers and slack adjusters and they truly add up to tops in stops. Take advantage of it—specify Bendix-Westinghouse, the world's most tried and trusted air brakes!

BENDIX-WESTINGHOUSE AUTOMOTIVE AIR BRAKE COMPANY
ELYRIA, OHIO BERKELEY, CALIFORNIA

DOLLAR FOR DOLLAR YOU CAN'T BEAT A

PONTIAC



Equipment, accessories and trim illustrated
are subject to change without notice.

*This could happen only
in the USA!*



You are looking at one of the handsomest, most desirable motor cars ever to grace our highways.

But you are also looking at something else—

You are looking at a truly luxurious American product which is so low in price that its ownership may reasonably be aspired to by the normal American family.

Nowhere else in all the world could a car so fine be brought within such easy reach of so many people. It is a privilege enjoyed only in the U.S.A.

Primarily, of course, this achievement must be scored as a tribute to America—to its resources, to its people,

and to the system of enterprise under which we cooperate with one another.

But we in the Pontiac organization—at the factory and in dealerships all over the country—feel that we have made *special use* of these priceless advantages.

By deliberate design, and with continuous effort, we have striven to have Pontiac embody all that is good and desirable in an automobile—and yet, by ingenuity of manufacturing, keep the price within reasonable reach of a great percentage of American families.

We recommend it to your attention as an outstanding example of the good things which we in America are privileged to enjoy.

PONTIAC MOTOR DIVISION of GENERAL MOTORS CORPORATION

BW



NOW FINGER-TIP STEERING!

... with PESCO HYDRAULIC PUMPS

Right now, many Americans are enjoying the thrill of hydraulic power steering for the first time. Complete and absolute control of the vehicle is obtained at all times . . . perfect safety, even on soft shoulders or in case of a blowout. Now, just the touch of a finger to the wheel, at any speed, and the vehicle responds surely and easily.

Less driver fatigue and increased pay loads for truckers are just two of the many benefits of hydraulic power steering.

Pesco engineers have worked hand in hand with automotive engineers in the development of a pump for this unit, which is one more in a long series of important developments in the field of *pressurized power and controlled flow*.

Investigate the advantages of hydraulic power steering for the vehicles you manufacture. Perhaps Pesco's experience can be helpful to you. Why not call us?



New Pesco Hydraulic Power Steering unit for passenger cars consists of pump and reservoir.



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24700 NORTH MILES ROAD • BEDFORD, OHIO

SuVeneer®

CLAD METALS

dense non-peeling
non-porous corrosion resistant impermeable



copper

or brass bonded inseparably to low carbon steel

Superior Steel

CORPORATION
CARNEGIE, PENNSYLVANIA

Here is your answer to the need for conserving critical metals: SuVeneer Clad Metals save up to 80% of solid copper or brass, while giving you every surface advantage of these strategic materials in your products. Actual copper or brass face one or both sides of the steel strip, in constant thickness-ratio for all strip gauges. Fabricate SuVeneer Clad Metal any way you like—the bond is mechanically inseparable—the production behavior is excellent! We'll gladly advise you on your applications, without obligation.

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always
right
with

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AUTO-LITE works to serve
the nation's needs in peace
and in defense. In 28 great Auto-
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Auto-Lite produces more than
400 products which are original
equipment on many makes of
America's finest cars, trucks,

tractors, airplanes and boats.
Their 40-year record of dependable
performance is summed up
in the phrase, "You're Always
Right With Auto-Lite."

THE ELECTRIC AUTO-LITE COMPANY
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Spark Plugs • Fuel Pumps • Batteries • Bumpers • Generators • Speedometers
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Starting Motors • Ignition Units • Instruments & Gauges • Windshield Wipers
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For The Third Consecutive Year **HOLLEY EQUIPPED CAR** Wins Mobilgas Economy Run

1952 Grand Champion Winner Equipped
with Holley Centri-Flo Carburetor
Economy engineered Holley carburetors and pressure
distributors have been original equipment on
the Grand Champion winners of the Mobilgas
Economy Run for three straight years.
In addition, the Holley record includes
seven class winners over the same period.
No other manufacturer of fuel and ignition
equipment can match this economy record!

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HALF A CENTURY—
ORIGINAL EQUIPMENT
MANUFACTURERS FOR THE
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DETROIT 4, MICHIGAN

ECONOMY-ENGINEERED HOLLEY PRODUCTS



HOLLEY CENTRI-FLO



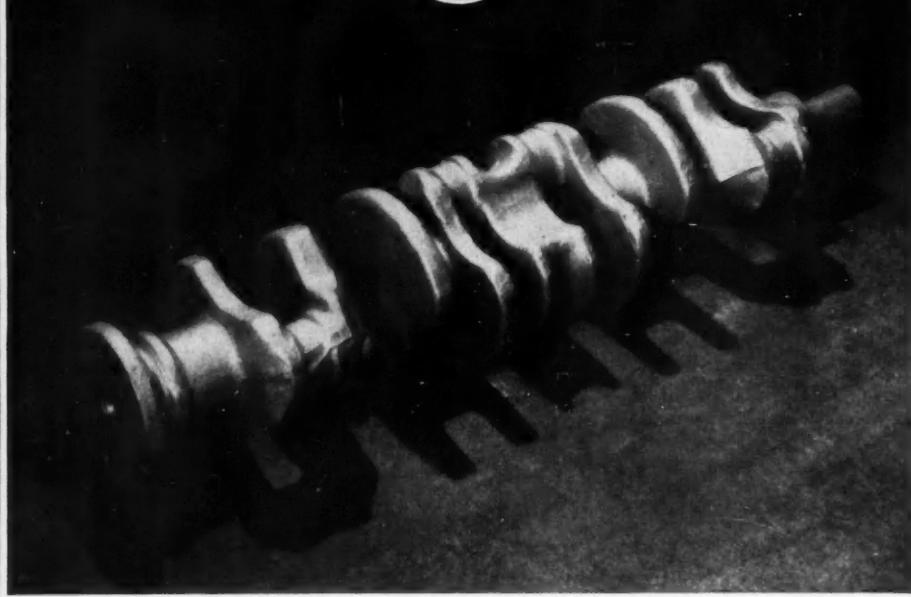
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AA-1 CARBURETOR



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Fully counterbalanced crankshaft—the ultimate in modern forging technique . . . Wyman-Gordon . . . crankshaft forging specialists since the introduction of the internal combustion engine . . . first to forge crankshafts with integrally forged counterweights

Standard of the Industry for More Than Sixty Years

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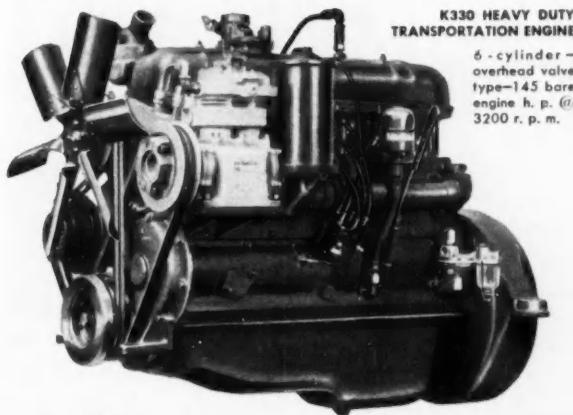
WORCESTER, MASSACHUSETTS

HARVEY, ILLINOIS DETROIT, MICHIGAN

There's a CONTINENTAL Model Engineered to Fit YOUR Job . . .

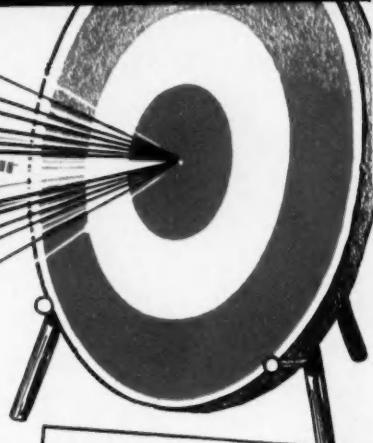
"RIGHT ON THE NOSE"

No matter what the specific requirements of your application, there's a Continental Red Seal model engineered and built to fill them, down to the very last detail—a model with exactly the right performance characteristics, profile, shape and weight . . . That is because Continental Motors produces some 80 basic models, to more than 2,000 different specifications, as set by vehicle, implement and equipment manufacturers' varying needs. When you buy a truck with a Red Seal under its hood, you get the fine result of 50 years' close collaboration between leading vehicle builders and Continental Motors engineers . . . Choose a truck with Continental Red Seal engine—gasoline, Diesel or L.P.G.—for the power, economy and long life that mean lowest ton mile costs.



K330 HEAVY DUTY
TRANSPORTATION ENGINE

6 - cylinder —
overhead valve
type—145 bare
engine h. p. @
3200 r. p. m.



TRANSPORTATION GASOLINE ENGINES

Model	Cyl.	Bore	Stroke	Displ.	Bare Engine H.P.
N4062	4	2 1/2	3 1/2	62	26.6 @ 3600 RPM
Y4069	4	2 1/2	3 1/2	69	28 @ 3400 RPM
Y4091	4	2 1/2	3 1/2	91	36 @ 3400 RPM
F4124	4	3	4 1/2	124	47 @ 3200 RPM
F4140	4	3 3/8	4 1/2	140	52 @ 3200 RPM
F4162	4	3 7/8	4 1/2	162	58 @ 3200 RPM
F6186	6	3	4 1/2	186	77 @ 3500 RPM
F6209	6	3 3/8	4 1/2	209	90 @ 3500 RPM
F6226	6	3 3/8	4 1/2	226	99 @ 3500 RPM
M6271	6	3 1/2	4 1/2	271	97 @ 3000 RPM
M6290	6	3 1/2	4 1/2	290	108 @ 3000 RPM
M6330	6	4	4 1/2	330	125 @ 3000 RPM
B6371	6	4 1/2	4 1/2	371	123.5 @ 3000 RPM
B6427	6	4 1/2	4 1/2	427	142 @ 3000 RPM
T6371	6	4 1/2	4 1/2	371	144 @ 3000 RPM
T6427	6	4 1/2	4 1/2	427	166 @ 3000 RPM
U6501	6	4 1/2	5 1/2	501	177 @ 2600 RPM
R6513	6	4 1/2	5 1/2	513	180 @ 2800 RPM
R6572	6	4 1/2	5 1/2	572	200 @ 2800 RPM
R6602	6	4 1/2	5 1/2	602	212 @ 2800 RPM
S6749	6	5 1/2	5 1/2	749	250 @ 2800 RPM
S6820	6	5 1/2	5 1/2	820	277 @ 2800 RPM
K6271	6	3 3/8	4 1/2	271	115 @ 3200 RPM
K6290	6	3 3/8	4 1/2	290	123 @ 3200 RPM
K6330	6	4	4 1/2	330	145 @ 3200 RPM

TRANSPORTATION DIESEL ENGINES

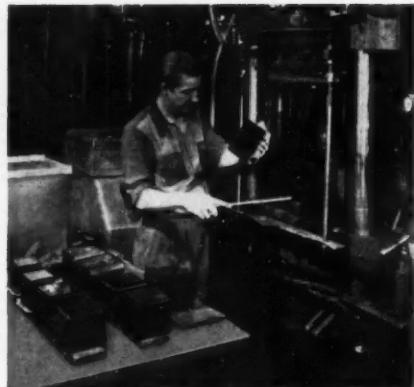
Model	Cyl.	Bore	Stroke	Displ.	Bare Engine H.P.
TD6427	6	4 1/2	4 1/2	427	112 @ 2400 RPM
RD6572	6	4 1/2	5 1/2	572	150 @ 2200 RPM

PARTS AND SERVICE EVERYWHERE

Continental Motors Corporation
MUSKEGON, MICHIGAN



New source of plastics
for the automotive industry
at United States Rubber Company's
Chicago Die Mold plant



One of the 40 Plunger Transfer and Compression presses in U.S. Rubber's new Chicago Die Mold Plant.



This is the newest unit in the nationwide chain of plants and laboratories which comprises United States Rubber Company.

This modern new plant houses the productive facilities and scientific personnel for wider excursions into the field of plastics, in the form of moldings, extrusions and fabrications.

For the automotive industry, this plant will produce plastics molded by injection and compression (transfer or plunger). It has its own mold manufacturing facilities. The equipment is of the most advanced type, and the engineers have at their command the great research stockpiles of the United States Rubber Company. This Chicago Die Mold Plant will supplement the "U.S." plant and laboratory at Fort Wayne serving the automotive industry.

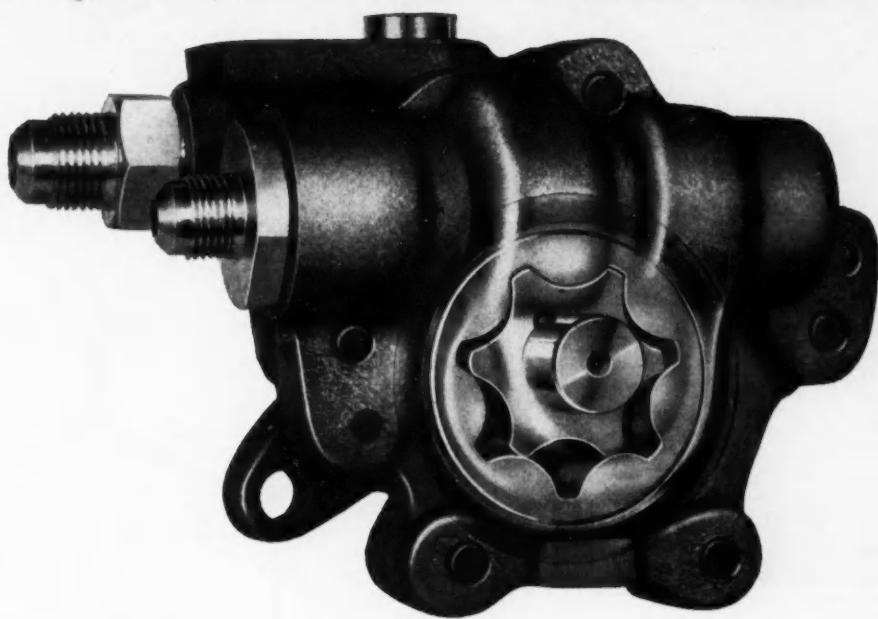


Other equipment in the plant includes 20 Injection Machines, with controlled mold temperatures.



UNITED STATES RUBBER COMPANY
MECHANICAL GOODS DIVISION • ROCKEFELLER CENTER, NEW YORK 20, N.Y.

Compact Power for Power Steering



Eaton Rotor Pumps with Flow-Control

Where space is at a premium, the Eaton high-speed power unit provides the advantage of small, compact design. As a pioneer in the development of pumps with flow control for hydraulic power steering, the Eaton Pump Division offers unequalled facilities in both design and production. If you are considering power steering, there are distinct benefits in permitting our engineers to work with yours in the early design stages.

EATON MANUFACTURING COMPANY
GENERAL OFFICES: CLEVELAND, OHIO



Pump Division • 9771 French Road • Detroit 13, Michigan



**this "sleeve"
gives valves a steady hand**

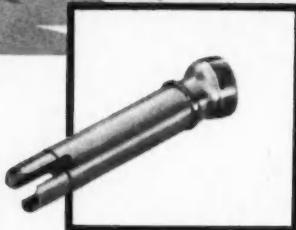
For clock-like precision in up-and-down motion, valve tappets require smooth-as-glass guides—"sleeves" tailored to 5/10,000 of an inch for snug, exact fit. For such precision work with a variety of products, leading manufacturers depend on Lycoming's production skill and resourcefulness.

Whether you require precision machining, high-volume production, product development—or air-cooled power for aircraft or ground applications—look to Lycoming! Long famous for aircraft engines, Lycoming offers extensive facilities and well-rounded experience.

For a more complete story on Lycoming's varied activities and facilities, write—on your company letterhead—for the interestingly illustrated booklet "Let's Look at Lycoming."



AIR-COOLED ENGINES FOR AIRCRAFT AND INDUSTRIAL USES • PRECISION-AND-VOLUME MACHINE PARTS • GRAY-IRON CASTINGS • STEEL-PLATE FABRICATION



To function precisely, an aircraft engine valve needs steady tappets. For a "guide" to steer tappets true, **Pratt & Whitney Aircraft called on Lycoming for precision production.**

LOOK TO

LYCOMING FOR RESEARCH
FOR PRECISION PRODUCTION

LYCOMING-SPENCER DIVISION
BRIDGEPORT-LYCOMING DIVISION



WILLIAMSPORT, PA.
STRATFORD, CONN.

Heavy-duty axles and shafts made without heat treating—with pre-hardened

free-cutting CARILLOY FC

● Every year, over 5 million tons of coal pour out of the 6 Fairmont, West Virginia region mines of Consolidation Coal Company (W. Va.). All repair and rebuilding of the hard-working equipment used in these mines are done at the company's Monongah, W. Va., maintenance shop.

Here, highly skilled machinists make everything from mine locomotive axles to armature shafts. Each new part they make must be as strong as the original, without benefit of heat treatment after machining.

So here is just the place for a very special kind of alloy steel.

Consolidation Coal Company (W. Va.) has found that they can produce practically all of the heavily stressed parts they use in their own shops—without heat treating—with a special grade of alloy steel, such as U-S-S CARILLOY FC steel. This pre-hardened, free-cutting alloy steel is received from the mill already quenched and tempered to the hardness required. No further heat treatment is necessary. Finished parts have a minimum tensile strength of 140,000 psi. and good surface finish.

U-S-S CARILLOY FC offers you important advantages if you have to make heavy-duty shafting or other parts that require 125,000 to 175,000 psi. steel. This deep-hardening manganese, chromium, molybdenum alloy steel is available quenched and tempered from 255 to 375 Brinell. You don't have the expense of heat treating after machining and you eliminate rejects caused by distortion and scaling.



HERE, in the Monongah, W. Va., maintenance shop of Consolidation Coal Company (W. Va.), a machinist turns a CARILLOY FC axle for a 20-ton locomotive.

* * *

CARILLOY FC is used in machining this great variety of parts. Notice the diversity of applications handled by one grade of alloy steel: (A) an armature shaft. The following parts are for loading machine: (B) loading clutch shaft, (C) conveyor take-up shaft, (D) conveyor hinge pin, (E) transmission clutch shaft, (F) caterpillar drive axle, (G) caterpillar idler axle, (H) sprocket shaft, (I) caterpillar take-up shaft, (J) hydraulic pump shaft, (K) caterpillar take-up screw.

For production work, remember that CARILLOY FC, easy to machine, is easy on your tools—some users report that tools last 300% longer, and more pieces can be produced per hour.

CARILLOY FC is available now, quenched and tempered or annealed, in all standard bar forms and sizes.

It costs only a fraction of a cent more per pound than ordinary through-hardening alloy steels.

UNITED STATES STEEL COMPANY, PITTSBURGH • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. • UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS

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Carilloy Steels

ELECTRIC FURNACE OR OPEN HEARTH

COMPLETE PRODUCTION FACILITIES IN CHICAGO OR PITTSBURGH

UNITED STATES STEEL

McQUAY-NORRIS

PISTON RINGS



Tried, and proved for over 40 years, the performance of McQuay-Norris piston rings is assured...and they are specifically engineered to meet every requirement, no matter how exacting.

McQUAY-NORRIS MANUFACTURING CO.
ST. LOUIS 10, MO.

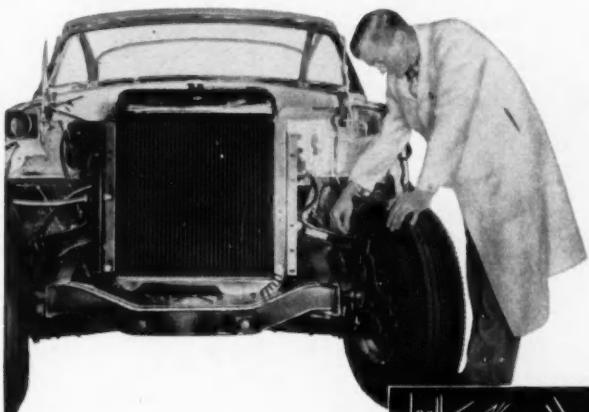




The "Steering Engineers" at Thompson's Detroit Division had a big part in bringing to the automotive industry the first major improvement in front wheel suspension in 20 years—Ball Joint Suspension.

The benefits are many—more space under the hood for wider engines . . . eliminates front suspension bind . . . gives better steering and handling . . . increases service life many times . . . greatly reduces front end overhaul time . . . reduces lubrication points from 12 to 4 per car . . . cuts assembly time—on production line or in garage . . . eliminates removing front wheels,

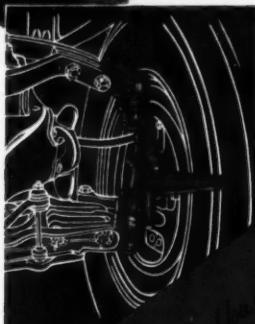
ENGINEERED STEERING BY THOMPSON...



bushings, draining brakes and realigning wheels when servicing the front end.

This is only one of many improvements in which Thompson's steering engineers have had a major part. Let us solve your steering problems. Our research, experience and manufacturing facilities are always at the disposal of *all* automotive manufacturers. Call us at WA 1-5010, Thompson Products, Inc., DETROIT DIVISION, 7831 Conant Ave., Detroit, Michigan.

The new ball joint suspension, developed by Thompson Products and Ford Motor Company engineers, made its first public appearance as standard equipment on all 1952 Lincoln car models. It is the most advanced improvement in front end suspension in 20 years.



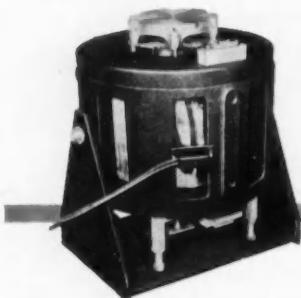
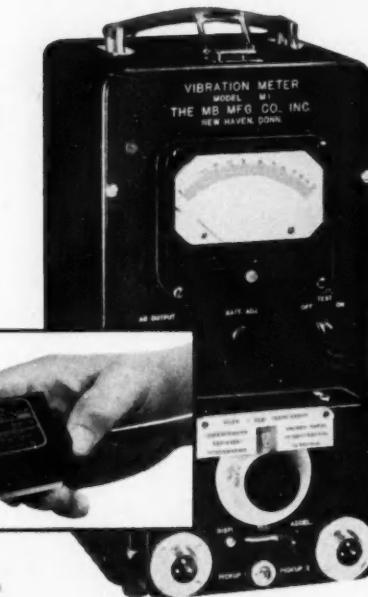
Thompson Products
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7831 Conant Ave.
Detroit 10, Michigan

How MB can help you

MEET MILITARY SPECIFICATIONS ON VIBRATION

DOES YOUR MILITARY PRODUCTION require vibration testing? Shock absorption—vibration isolation? Representative of MB's specialized vibration engineering, these products show that, from a single source, you can get the equipment and information you need to meet your requirements. For example:

1. MEASUREMENT of vibration with MB vibration pickup and meter supplies data for study of disturbing frequencies and for design adjustments. The electrically damped and highly sensitive pickup is convertible for horizontal or vertical operation. Meter gives you accelerations, velocities or displacements of the vibrations directly. Made for each other, the two are the "eyes" for any vibration testing program.



2. SHAKE TESTING TO MIL-E-5272 and 41065-B is easily accomplished with MB Vibration Exciters. Model S-3 shown delivers 200-lb force. Others available with 10-lbs to 2500-lbs force ratings—all easily, quickly and accurately controlled for force and frequency.



3. ISOMODE* SHOCK MOUNTS have been developed for supporting and protecting aircraft engines from damage while transported in crates or "cans." High load capacity combined with high deflection capacity provides good absorption of shock. *Reg. U.S. Pat. Off.



4. MIL-I-5432 (AN-I-16a) can be met with the Type 17 ISO-MODE Mount. This unit available for loads from 0.5 to 100 pounds, and controls all modes of vibration with equal efficiency because of equal spring rate in all directions.

Remember, if you need help with a vibration problem, you can save yourself time and work by contacting MB's vibration specialists. For details on any of the above products, address your inquiry to Dept. N7.

THE **MB** MANUFACTURING COMPANY, Inc.
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PRODUCTS FOR MEASUREMENT . . . REPRODUCTION . . . AND CONTROL OF VIBRATION



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steer you

the wrong way.

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Among other obligations...

When an order is accepted the obligation to supply the commodity as stated in the contract is routine. But every purchaser knows that there are many other and additional services that the seller can render which serve the convenience and interests of the customers.

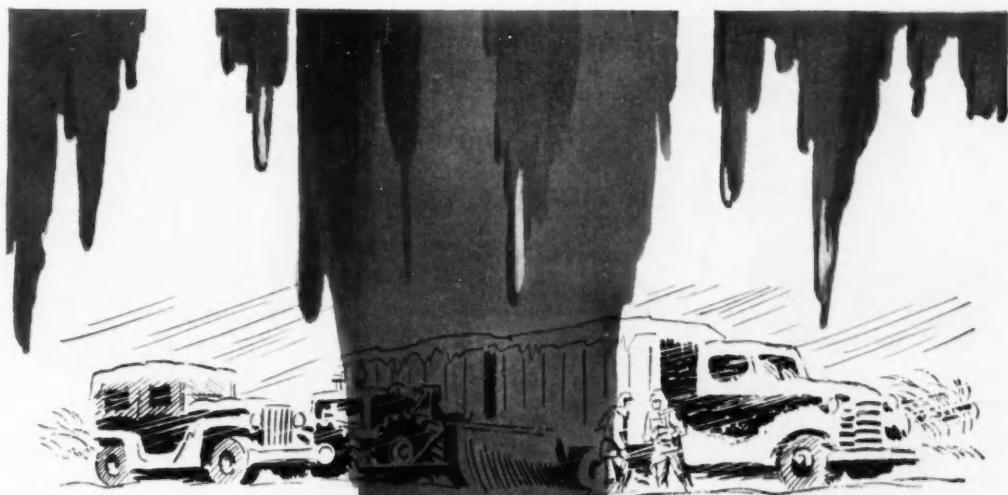
Along with every order accepted by the Bunting organization is also accepted the obligation to cooperate with the customer as well as to deliver the items as specified.

Ask any Bunting customer.

Bunting
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The sleeve bearing is not complex in structure; it conforms readily to design requirements; it is easily installed. Cast Bearing Bronze is the most adaptable of all sleeve bearing materials; it possesses excellent anti-friction properties. With proper film lubrication, its coefficient of friction is as low as can be obtained with any other bearing type. A successful Bunting Bronze bearing installation is readily attainable. We ask the opportunity to work with you, and to quote on your requirements.

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When they gotta go... at 65° below!

Perfection engineers are ready to give you the full benefit of our 15 uninterrupted years of designing and producing winterization systems for all types and sizes of vehicles and equipment.

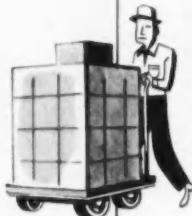
Over 100,000 Perfection systems are in service today. Ask for our Winterization Data File. Perfection Stove Company, 7342-B Platt Avenue, Cleveland 4, Ohio.

To be *sure* your equipment and vehicles will "go" in sub-arctic service... be sure you get the *right type* of heating system. Come to the people who have successfully developed and produced **BOTH AIR AND COOLANT-TYPE ENGINE HEATERS**.

HERE'S WHAT WE DO

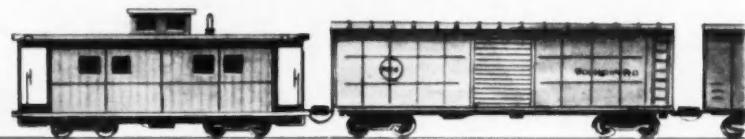
1. Develop the winterization system.
2. Apply it to the vehicle or equipment.
3. Test it to government specifications in our Cold Rooms.
4. Prove that it meets those specifications.
5. Guarantee that the equipment will go at 65° below!
6. Make the drawings for your production, or produce the systems for you.

Perfection



Cartons...

or Carloads



You can depend on us to meet your most exacting requirements for precision engine-bearings in small runs or mass-production quantities.

Our special skills and exclusive processes have been developed over the years to meet the challenge of today's shifting demand for automotive and industrial engines.

When you specify our engine-bearings for your production, you are selecting a manufacturer who has been a leader in the field for over 25 years.



DETROIT ALUMINUM & BRASS CORP.

DETROIT 11, MICHIGAN

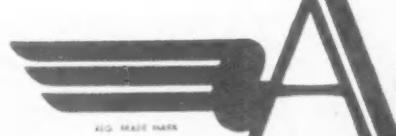


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DEVELOPED first

PRODUCED first

By

 **Aeroquip**

AEROQUIP CORPORATION, JACKSON, MICHIGAN

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MINNEAPOLIS, MINN. • PORTLAND, ORE. • WICHITA, KAN. • TORONTO, CANADA

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10 years of progress in aircraft hose standards have been paced by Aeroquip's 10 years of company history. Through constant research and development, Aeroquip has repeatedly anticipated the ever-changing requirements of the aircraft industry. The assistance and cooperation of B. F. Goodrich Co., The Army Air Forces, U. S. Navy Bureau of Aeronautics and C.A.A. are gratefully acknowledged in the development of these Aeroquip products.

DOW CORNING
SILICONES

make motors last longer



Photo courtesy Whirlpool Corporation, St. Joseph, Michigan

Eliminate another common cause of motor failure; lubricate bearings with Dow Corning 44 Silicone Grease.

Especially designed for ball bearings operating at a maximum speed factor (bore in m.m. x rpm) of 150,000 to 200,000 and at temperatures from -40° to 400°F, Dow Corning 44 Grease is practically nonvolatile and highly resistant to oxidation. In open and single shielded bearings designed for high temperature operation, Dow Corning 44 has 8 to 10 times the life expectancy of conventional greases. It gives life-time lubrication in permanently sealed bearings.

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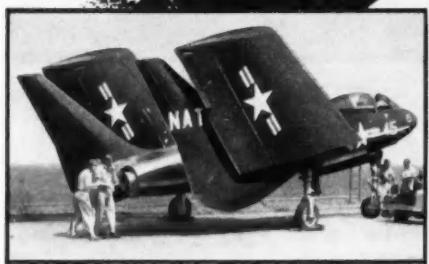
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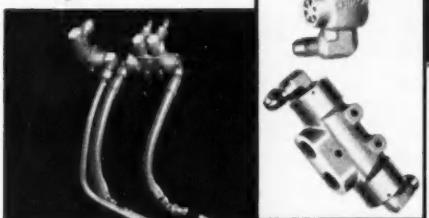
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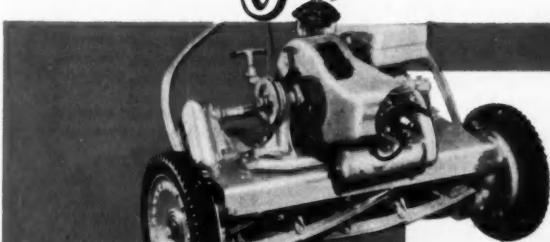


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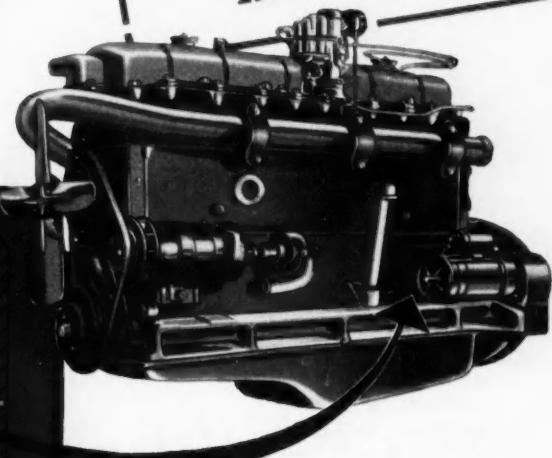
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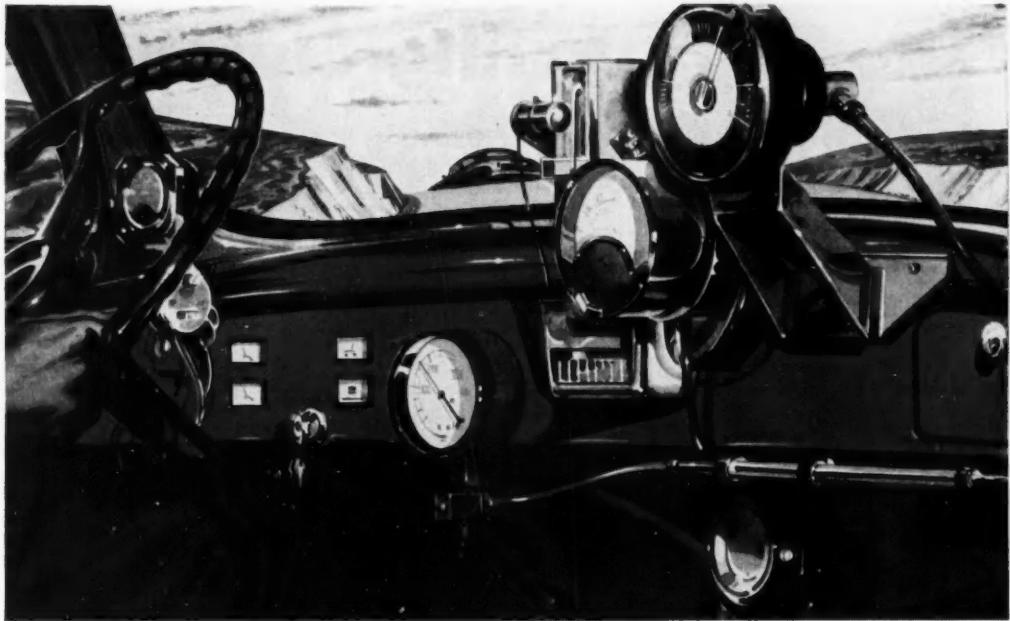
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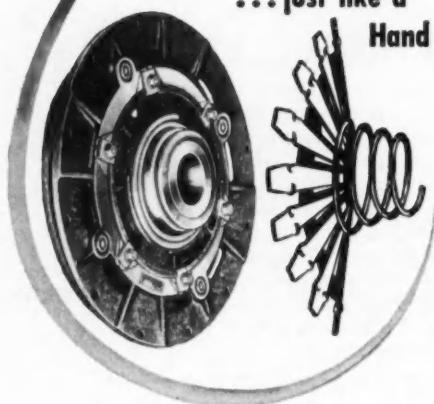
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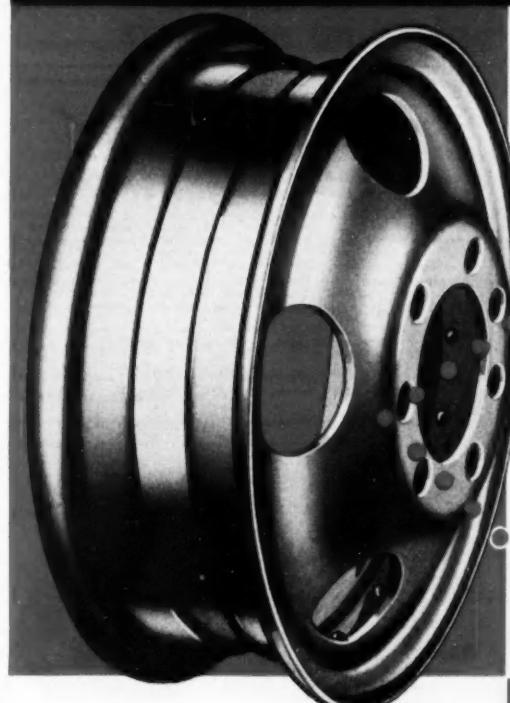
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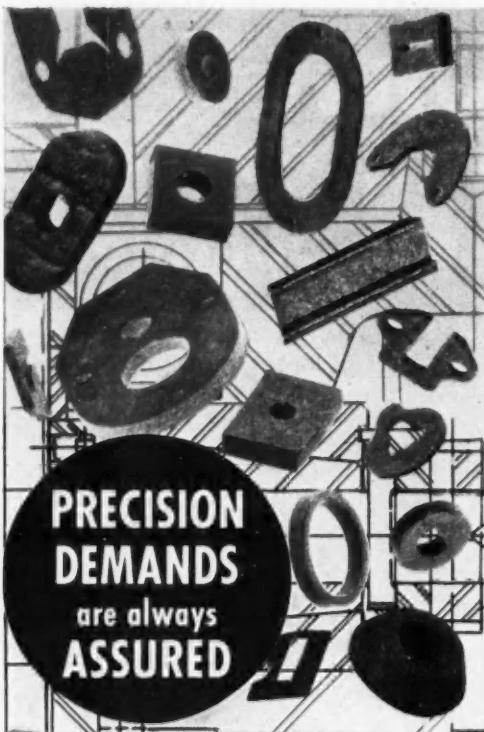
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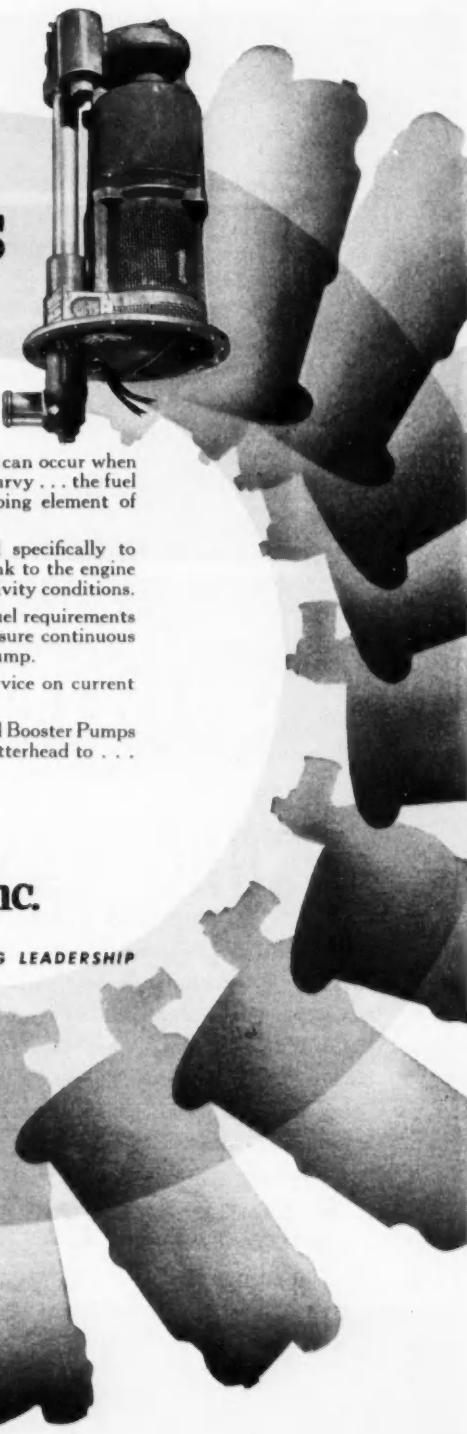
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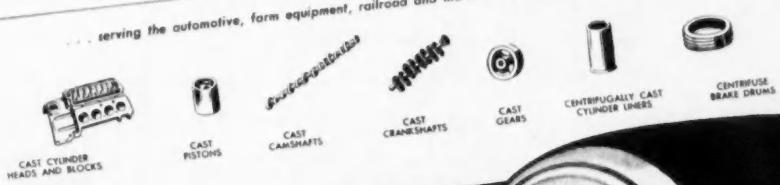
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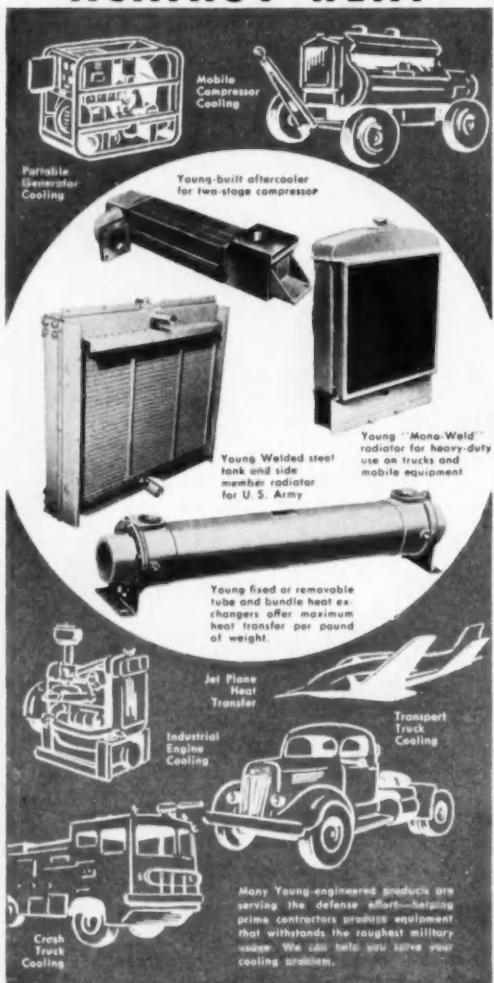
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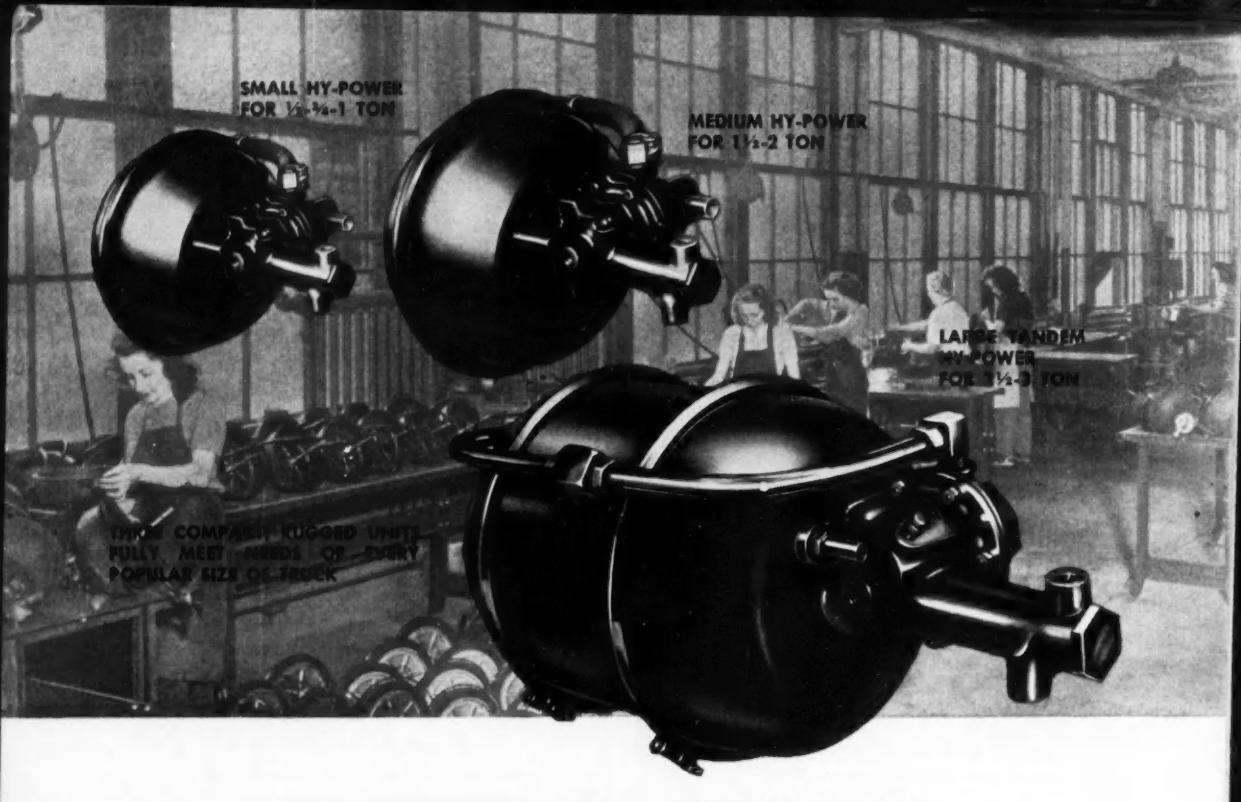
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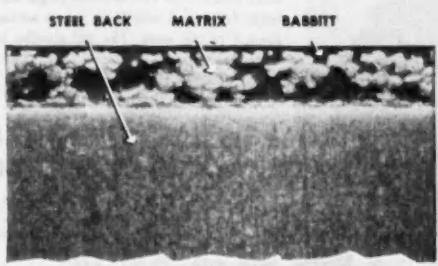


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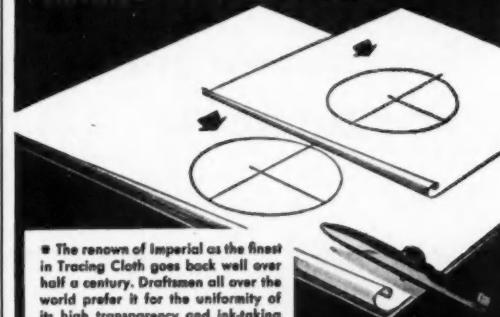
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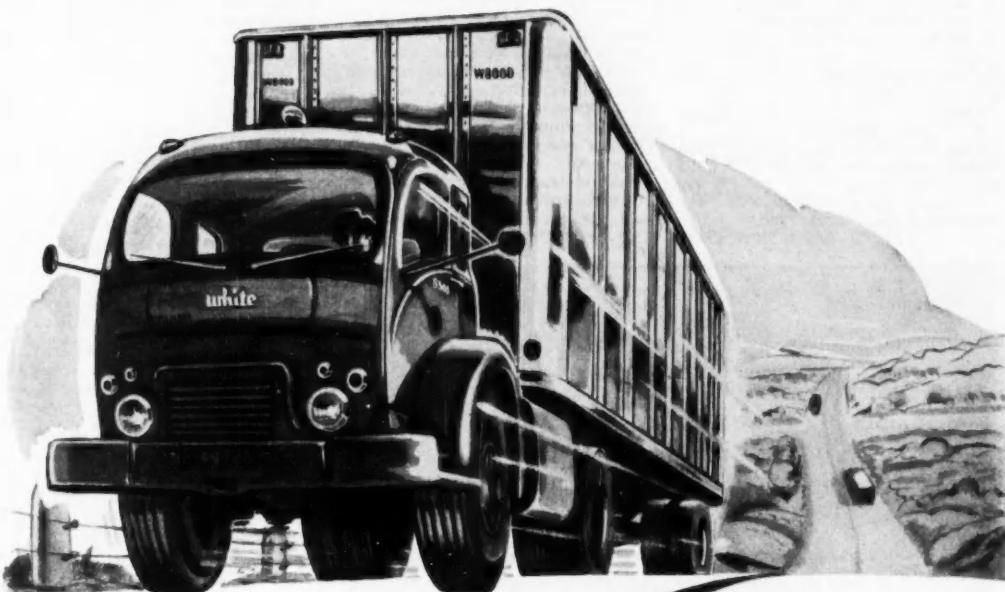
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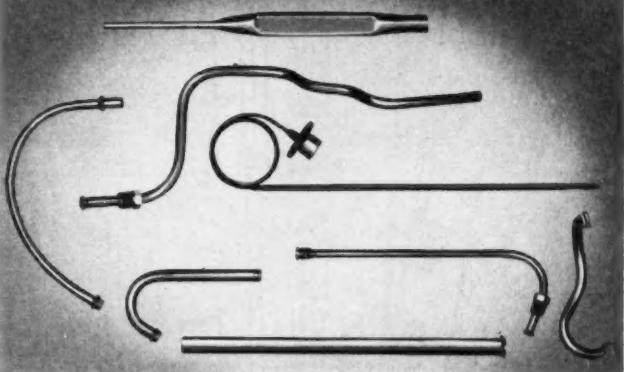
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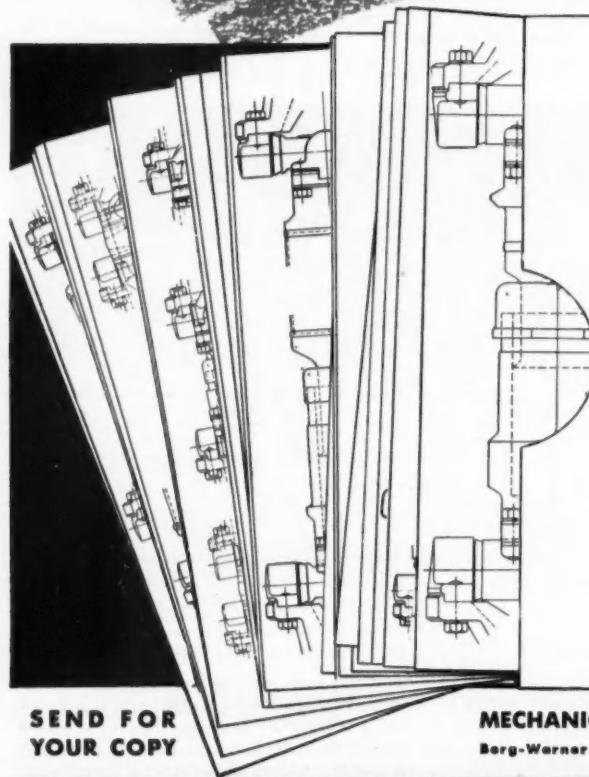
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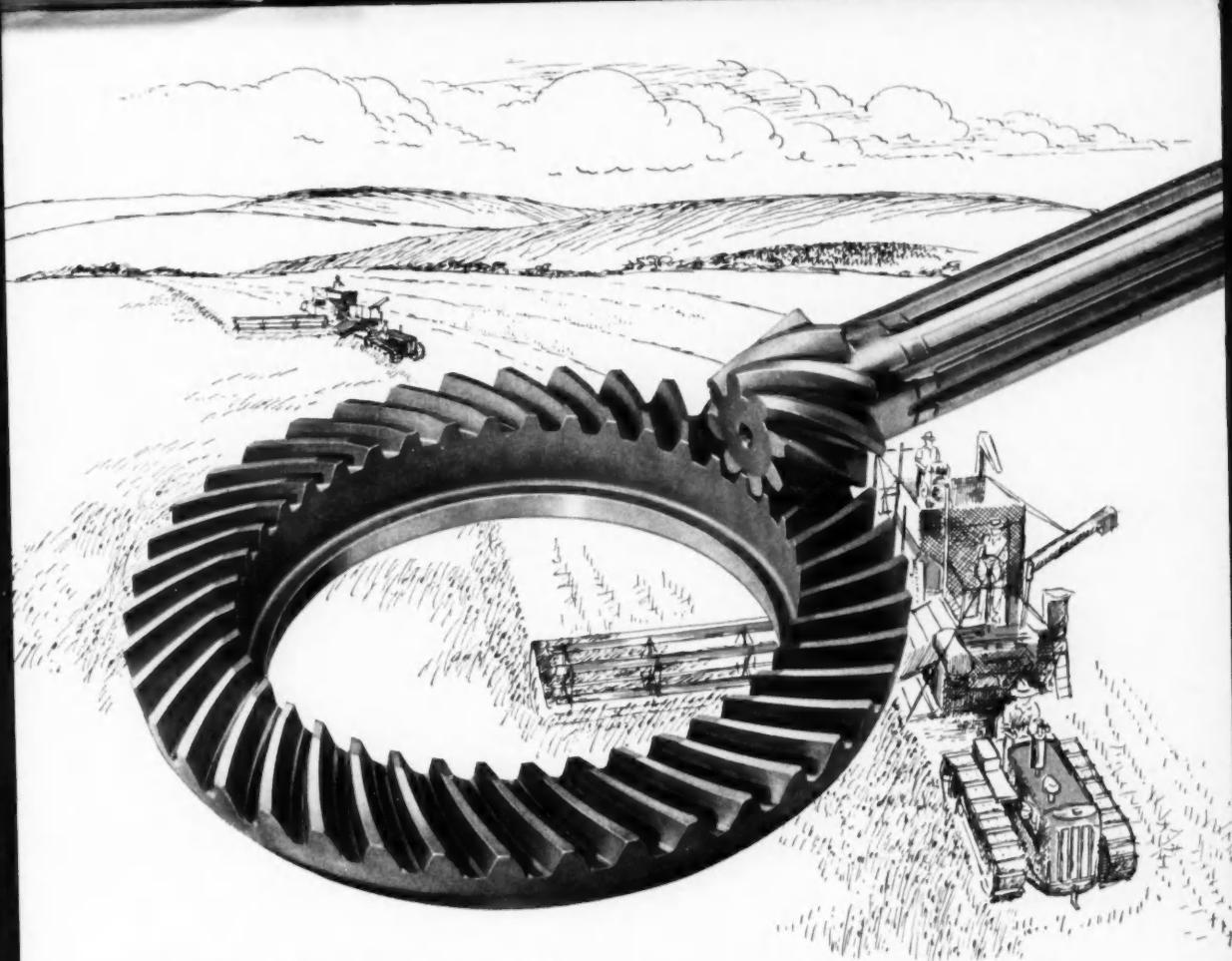
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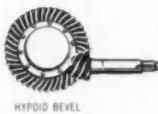
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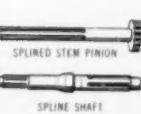
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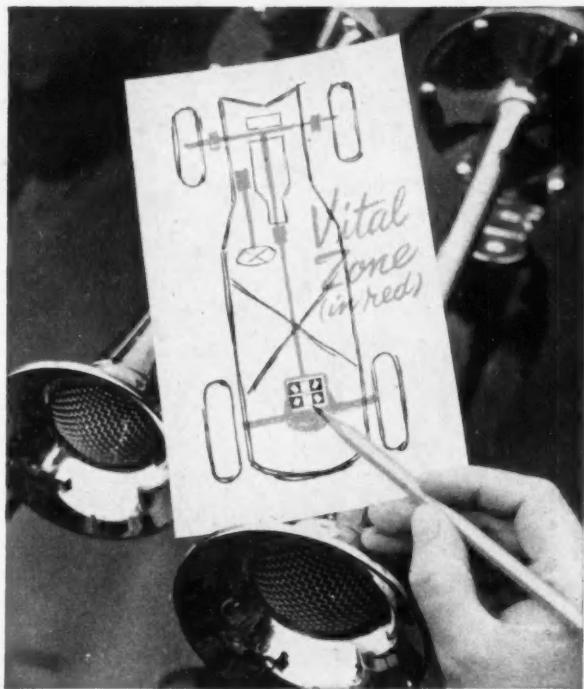
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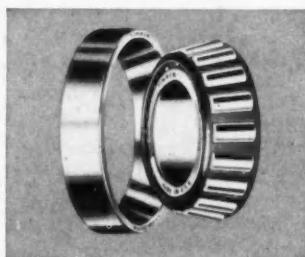
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